P148563.PDF [Page: 3 of 96]

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CONTRACTOR REPORT DREO/PSD/CPS - 36/86

IDENTIFICATION OF ALTERNATIVE PROTECTIVE SYSTEMS

PART 2 OF WATER ADSORPTION AND DESORPTION RATES ON ASC CHARCOAL

By

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FINAL REPORT

ASC WHETLERITE CARBON

WATER ADSORPTION & DESORPTION RATES

TITLE: Identification of Alternative Protective System

CONTRACTOR: Calgon Carbon Corporation

DSS FILE NUMBER: 13SV.97714-4-2835

SERIAL NO.: 2SV85-00058

OBJECTIVE #2

Determine the effect of relative humidity on the rate of moisture adsorption and desorption on ASC Whetlerite activated carbon. If possible, derive equations which will predict these effects.

Submitted: December 19, 1986

TABLE OF CONTENTS

	Page
INTRODUCTION	1
SUMMARY AND CONCLUSIONS	2
RECOMMENDATIONS	4
EXPERIMENTAL	5
DISCUSSION	7
APPENDIX A - EXPERIMENTAL DATA	
APPENDIX B - EQUIPMENT LIST	
APPENDIX C - COMPUTER PROGRAM FOR DATA ACQUISITION	

INTRODUCTION

Background: When Type ASC carbon is used for personal or collective protection in the field, it is exposed to moisture in the air. Excessive moisture pickup may hinder the dynamics of physical and chemical adsorption. It would be useful to have some knowledge of the rate at which Type ASC Whetlerite adsorbs water vapor to determine when significant water has been adsorbed, which might reduce the effectiveness of the carbon as a filter for chemical agents. A method of predicting water pickup rate from information on relative humidity and exposure time in the field would be quite useful.

Possible desorption methods would also be valuable to know in order to extend the use of a particular filter.

This study addresses these concerns and together with the previously issued report (1) on the literature pertaining to ASC performance factors fulfills the contractor's obligation under this contract.

Objective: Determine the effect of relative humidity on the rate of moisture adsorption and desorption on ASC Whetlerite activated carbon. If possible, derive equations which will predict these effects.

(1) ASC WHETLERITE CARBON
LITERATURE REVIEW - OBJECTIVE #1
Submitted 9/8/86

SUMMARY AND CONCLUSIONS

1. From the data obtained in these experiments, it was determined that the amount of water adsorbed (W) at time (t) and constant relative humidity (RH) could be described as a function of the equilibrium moisture adsorbed (Ws) at constant RH according to the following equation where the term 'b' is the rate constant.

$$W \quad Ws\ (1 - e^{-bt})$$

2. It was also demonstrated that the rate constant 'b' in the above equation is the slope of the line formed by plotting $-\ln (1-W/Ws)$ versus t.

3. The value of b_{ads} for base carbon is higher than the values for ASC at 60% relative humidity and above. Below 60% relative humidity the ASC carbon adsorbs more water while the amount of water adsorbed by the base carbon is significantly less.

4. Variation of b_{ads} for the base carbon and ASC carbon with relative humidity can be described by the quadratic function.

   $b = 1 + A(RH) + B(RH)^2$ where A and B are coefficients determined from the data for a specific carbon.

5. The value of b_{ads} is markedly increased for carbons which have been desorbed with dry air and then allowed to readsorb water vapor. This phenomenon could be due to chemisorption of oxygen which makes the carbon surface more hydrophilic.

6. The value of b_{des} can be described by a relation similar to that described in Conclusion 1. If the instantaneous water loss and total water loss are substituted for the instantaneous weight and total weight adsorbed.

7. The value of b_{des} is higher for both the base and ASC carbons when compared to b_{ads}. This indicates more rapid desorption when the carbon is subjected to totally dry air.

   Dual rate constants b_{1des} and b_{2des} might better describe the desorption phenomenon.

8. The variation of b_{des} with ^RH can also be explained by a quadratic equation.

9. Upon desorption by reducing RH from near saturation (RH>80) by small increments (20 RH units), both carbons fail to return to adsorbed equilibrium values at the final RH. The b_{des} values are much lower than when dry air was used to desorb. Thus hysteresis may be the result of surface oxidation.

10. From a practical standpoint the rate constants determined from the data of these experiments can be used to estimate the approximate amount of moisture adsorbed on the carbon for a given time at a given RH. These data have shown that within 24 hours essentially all of the carbons were equilibrated. More exact estimates for carbon in a canister can be made by dividing the weight constants determined from these experiments by 3 (since the average weight of carbon used in the experiments was 0.3 grams), then multiplying by the weight of carbon in the canister.

11. From conclusion 8 above it can be deduced that it may be possible to desorb water from ASC if a source of dry air is available.

RECOMMENDATIONS

1. The hysteresis effect seen in these experiments should be further investigated. One approach might be to repeat the sequential desorption experiments in nitrogen instead of air.

2. An improved apparatus should be constructed within a constant temperature cabinet, such as an incubator to provide more rigid control over the relative humidity of the experiment.

3. Predicted and observed H_2O adsorption rates should be checked on full size canisters in a humidity cabinet with intermittent weighing over time and at relative humidities above 50%. With these refinements the data obtained here might prove very useful in the field for extending the life of canisters.

EXPERIMENTAL

1. Activated Carbon -- The test carbons used were ASC Whetlerite and the base carbon for ASC Whetlerite carbons. The characteristics of these carbons are given in Table 1.

2. Compressed Air -- Zero grade

3. Equipment

   A detailed list of the equipment is given in Appendix B. The flow arrangement for the equipment is also given in Appendix B, Drawing #1. The sample cell is detailed in Drawing #2 in Appendix B.

PROCEDURE

Referring to the flow diagram in Drawing #1, Appendix B, zero grade air from a cylinder was sent through the mass flow controller which regulated the total air flow at 200 ml/min. Air could then pass either directly through to the relative humidity sensor or could be bypassed by means of the needle valve through two gas scrubbing bottles which acted as moisture saturator and spray control devices. From there the air passes through the relative humidity sensor and into the sample cell chamber. Details of the cell shown in Drawing #2 illustrate the nichrome wire basket of approximately 2 ml volume suspended from the balance wire attached underneath the digital balance.

The needle valve shown in the diagram had a micrometer dial which could be reset in order to repeat approximate humidity settings. Prior to the start of a test run, the appropriate humidity was selected by turning the micrometer dial on the needle valve to the proper setting which had been predetermined for a particular humidity. The entrance and exit valves (A and B)to the humidifying train were closed, and the sample cell was purged with dry air. The tared sample basket was removed and approximately 0.2 to 0.4 g of the activated carbon to be tested was placed in the basket. The sample basket was then returned to its position at the end of the wire

on the bottom of the balance as shown in Drawing #2. Once the sample cell was reconnected, the program STARTER . BAS (Appendix C) was begun on the IBM. File identification information was entered, the apparent density of the activated carbon is then entered, and the program records and averages 12 weights to arrive at a starting sample weight. After the starting weight is obtained, the operator opens the valves A and B to the humidified airstream. Humidified air blends with the dry air and STARTER . BAS calls DATACO . BAS which passes the file name, starting weight, and starting time to DATACO. This program collects data and prints raw data and data that has been converted into useful units to the screen and the printer every 20 minutes. The data collected are elapsed time in minutes, the percent by weight loading and the percent relative humidity within the cell. This information is also stored in a file on the disk with the .PRN extension.

When the operator determines that equilibrium has been reached (as indicated by zero change in weight between three 20-minute periods or less than 2mg pickup over 2 hours), the program is stopped by a break command from the terminal. The collected data is then saved as a file on a floppy disk.

For desorption of the previously moisture equilibrated carbon, the starter program is reinitiated and desorption mode is selected from the program menu. At this point the initial dry starting weight of the test carbon is entered from the terminal. Valves A and B are closed, and dry air is admitted to the sample chamber. The computer then continues to take readings every 20 minutes as desorption proceeds. This operation continues until the sample reaches its initial dry weight or no further loss in weight is observed.

In experiments with sequential desorption, the program was not stopped after equilibrium was reached at the highest relative humidity. Instead the relative humidity was lowered approximately 20 points by adjusting the needle valve to a new setting. Data were taken until equilibrium was achieved or loss in weight was less than 2 mg over a 2 hour period. At that point the humidity was lowered an additional 20 points and a new equilibrium was reached at the lower relative humidity.

The ASC II files produced during the experiments were imported into the Lotus 123 spreadsheet program. The data was analyzed to produce the exhibits in Appendix A. Lotus Printgraph program was used to produce the plots in the Figures in this report. The plots were printed on the Epson printer under high resolution setting in most instances.

A PC program called XSTAT was used to perform the multiple linear regression necessary to correlate RH and the 'b' values.

Table 1

Activated Carbon Characteristics

	ASC 12x30	Base Carbon 12x30
Metal Loadings		
Chromium	2.6% by weight	0.0%
Copper	7.5% by weight	0.0%
Silver	0.05% by weight	0.0%
Apparent Density = g/ml	0.602	0.490
CCl_4 No.	52.13	67.93
Screen Analysis % by wt.		
On 8 U. S. Sieve	0.0	0.0
On 12 U. S. Sieve	0.1	0.1
On 16 U. S. Sieve	20.5	20.3
On 20 U. S. Sieve	55.3	55.8
On 30 U. S. Sieve	22.9	20.3
-30 U. S. Sieve	2.1	1.3

DISCUSSION

Using the device described in the experimental section, water adsorption and desorption tests were performed on the base carbon and on Type ASC carbon.

Equilibrium Water Adsorption -- Figure 1 is a graphical representation of equilibrium water adsorption as % by wt adsorbed for ASC and the base carbon with respect to relative humidity. These data reveal the fact that at relative humidities below 50%, ASC carbon adsorbs more water than the base carbon. At 60% to 95% relative humidity, the base carbon adsorbs more water to equilibrium. The first phenomenon might be due to hydration of the impregnants, while the second phenomenon reflects the reduction in available pore volume due to the volume either occupied or occluded by the impregnants on Type ASC carbon.

Sequential Desorption of Water -- Figures 2 (base carbon) and 3 (ASC) were obtained by plotting the effect of lowering the relative humidity and reestablishing a new equilibrium loading at the lower relative humidity. The base carbon already equilibrated with 47% by wt. H_2O at 85% relative humidity when allowed to re-equilibrate at 60% relative humidity still retained 42% by wt. H_2O (first plateau in Figure 2). This value compares to 34% by wt. for adsorption at 60% relative humidity (Figure 1). The second plateau in Figure 2 represents the 44% relative humidity equilibrium. The 16% by wt. water pickup compares to only 4% by weight on adsorption (Figure 1).

ASC (Figure 3) water adsorption was reduced to 34% by wt. on sequential desorption from 92% to 60% relative humidity compared to 25% by wt. on the adsorption at 60% relative humidity curve (Figure 1). There was no significant hysteresis at 41% relative humidity, but the ASC carbon still retained 3% by wt. H_2O when exposed to dry air.

As will be shown below hysteresis was not evident for ASC or the base carbon when desorption was carried out with dry air immediately after steady state water adsorption was achieved.

Figure 1

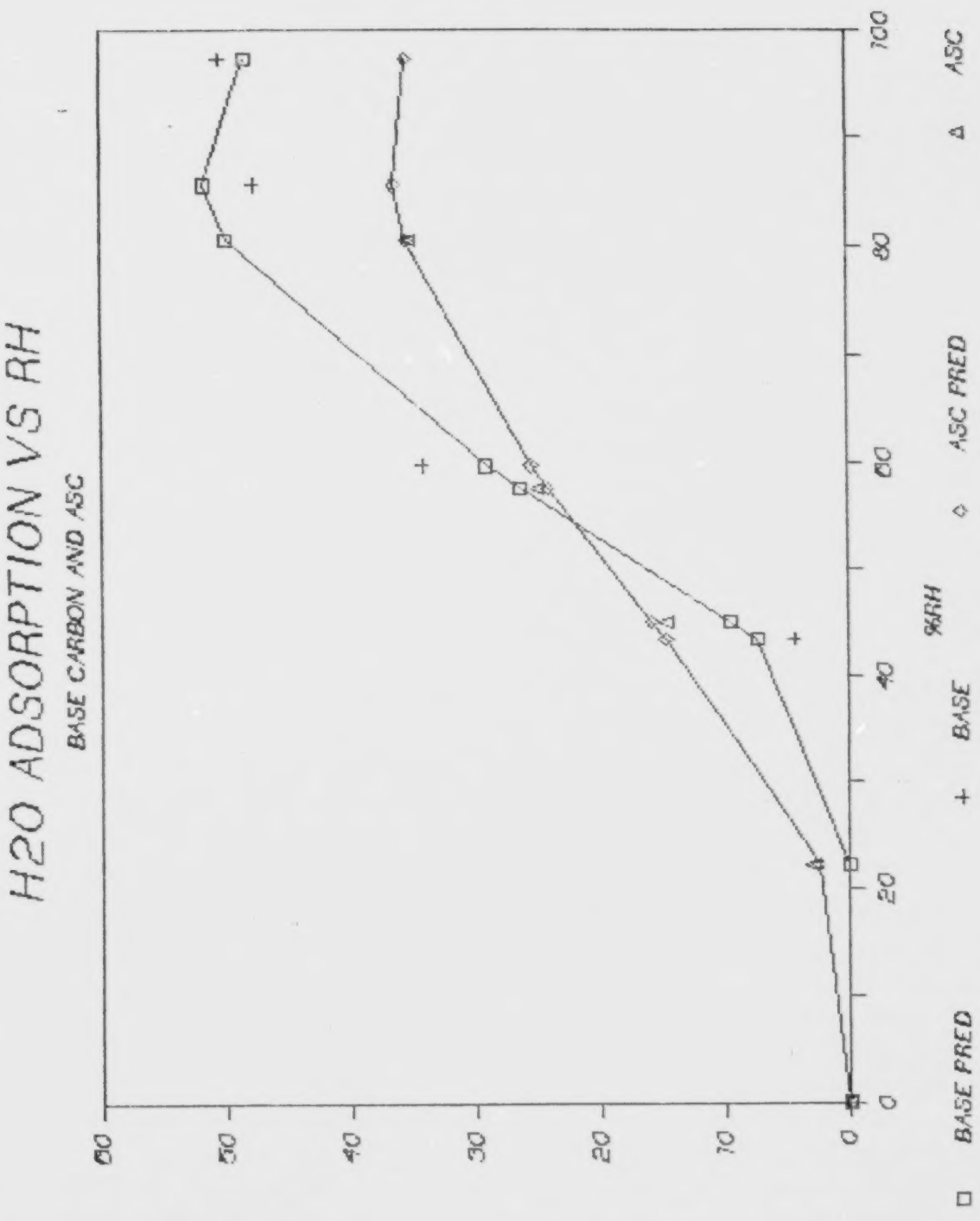
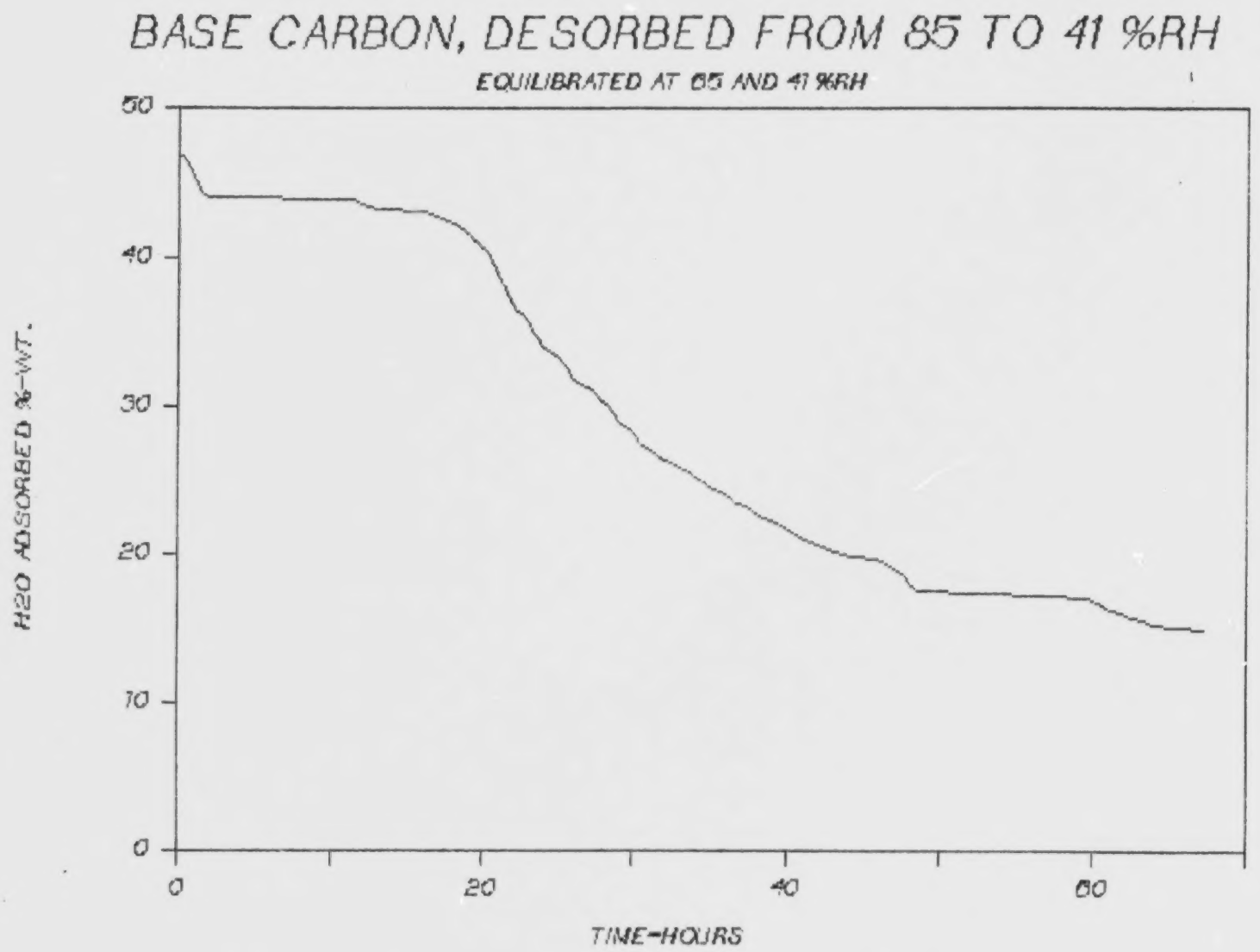
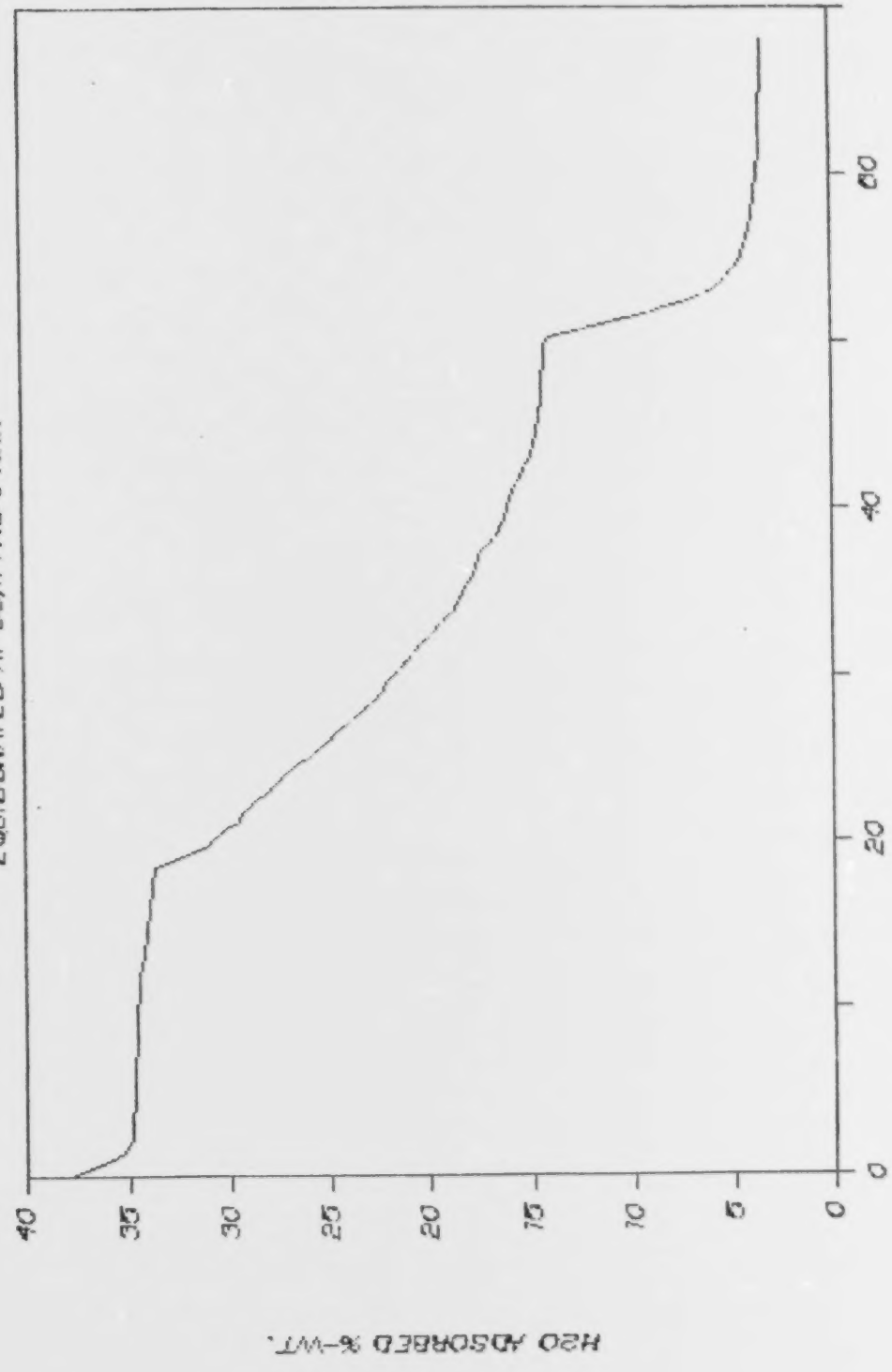

H20 ADSORPTION VS RH
BASE CARBON AND ASC
H20 ADSORBED %-WT.
0
10
20
30
40
50
60
0
20
40
60
80
100
%RH
BASE FRED
BASE
ASC FRED
ASC

Figure 2



P148563.PDF [Page: 17 of 96]

Figure 3


ASC DESORPTION FROM 92 TO 0 %RH
EQUILIBRATED AT 63,41 AND 0 %RH
H2O ADSORBED %-WT.
TIME-HOURS
0
5
10
15
20
25
30
35
40
0
20
40
60

Water Adsorption Rates -- Water adsorption rate curves were obtained on base carbon and ASC carbon at 20 to 97% relative humidity. The data collected were then analyzed using an error function curve which would describe the rate of adsorption with time and satisfy the conditions of zero adsorption at zero time and zero weight of rate change at infinite time.

Equation 1 below satisfies these conditions:

$$W = Ws(1-e^{-bt}) \qquad (1)$$

W = weight at time t

W_s = steady state weight adsorbed

b = rate constant

t = time in hours

The rate constant 'b' varies with time such that equation 2 below is a straight line function.

$$-\ln (1-W/Ws) = c + bt \qquad (2)$$

The constant 'b' in equation 1 is the slope of the fitted line described by equation 2.

Table 2

ASC Adsorption Rate Summary

Exhibit Number	Initial % RH	H_2O Adsorbed % Wt.	Rate Constant b	Corr. Coef. R_2
1	21	2.5	0.262	0.794
2	23	3.5	0.216	0.875
3	45	15.1	0.271	0.974
4	45	14.5	0.287	0.938
5 (*)	45	17.0	0.479	0.969
6	59	23.4	0.269	0.928
7 (*)	57	25.9	0.687	0.891
8	84	37.9	0.177	0.841
9 (*)	85	39.7	0.434	0.891
10 (*)	80	32.5	0.622	0.996
11 (*)	80	31.3	0.760	0.991

(*) Denotes Readsorption

Table 2 above summarizes data obtained on Type ASC carbon for water. The exhibit numbers refer to the data listing and regression data in Appendix A. The term 'b' (adsorption rate constant) is from equation 1 derived as explained previously. The correlation coefficient refers to the fit of the straight line equation 2.

When the carbon was originally exposed to the humid stream, the lower adsorption rate values were obtained. However, after complete desorption by passing dry air through the cell and subsequent re-exposure to water vapor, the adsorption rate increased. Note that at the 59% RH level, the rate more than doubled (Exhibits 6 and 7 and Table 2). This could be due to oxidation of the surface during the previous adsorption and desorption cycle to make the surface more hydrophillic.

The correlation coefficients are in fair agreement, since they represent a large number of individual weight and time determinations. At the 20%

relative humidity range, equilibrium was achieved quickly so that there were fewer points. Also the small weight gain would have a larger reading error.

Correlation improved somewhat at the higher relative humidities. At these levels the greatest error was introduced by variations in relative humidity caused by variation in room temperature. The sample area was insulated to reduce variations. Future work should be conducted inside a chamber such as an incubator which has both heating and cooling ability in order to maintain the humidification train and the sample chamber at constant temperature.

Table 3

Base Carbon Adsorption Rate Summary

Exhibit Number	Initial % RH	H_2O Adsorbed % Wt.	Rate Constant b	Corr Coef. R^2
12	26	2.3	NA	NA
13	44	4.5	0.089	0.781
14	59	34.3	0.124	0.969
15(*)	60	32.4	0.507	0.903
16	60	33.1	0.093	0.964
17(*)	62	32.2	0.344	0.813
18(*)	60	31.0	0.331	0.900
19	85	46.9	0.276	0.985
20	83	47.5	0.223	0.967
21	97	50.4	0.118	0.836

(*) Denotes Readsorption

The base carbon summary in Table 3 above demonstrates the higher equilibrium water adsorption of the base carbon at relative humidities above 50%. Comparing exhibits 14 and 15 in Table 1 it is evident that the adsorption rate increased substantially on readsorption. This indicates that the phenomenon described previously is not related to the impregnants, but is a characteristic of the base carbon.

The data for water adsorption at 26% relative humidity were not sufficient to calculate the rate constant. In general, the adsorption rates ('b' values) for ASC carbon in Table 2 are higher than the values for the base carbon in Table 3. This may be a natural consequence of the lower total pore volume of ASC carbon due to the filling or blocking of pores by the impregnants.

Effective Relative Humidity on Rate -- A casual observation of the trend for 'b' is that it appears to reach a maximum at about 80% relative humidity for the base carbon and at 60% relative humidity for the ASC carbon. This would indicate a quadratic relationship between RH and 'b'. In fact, good correlation is achieved if one fits rate constant 'b' versus relative humidity data to a quadratic equation.

The correlations were done separately for initial water adsorption experiments and readsorption experiments due to the large increase in rate upon readsorption discussed earlier. Equations 3 and 4 below describe the relationships between 'b' for initial adsorption on base carbon and ASC carbon respectively.

$$b = -2.0029 + 0.05738(RH) - 0.0003661(RH)^2 \quad (3)$$

$$b = 0.12919 + 0.006541(RH) - 0.00007105(RH)^2 \quad (4)$$

The correlation coefficient R^2 for the fit of equation 3 was .9705 and "R^2" for equation 4 was .9829. The rate for readsorption of water on ASC carbon is described by equation 5 below. The correlation coefficient for readsorption rate was 0.818 which is not in as good agreement as the data for initial adsorption.

$$b = -2.4859 + 0.09983(RH) - 0.000763(RH)^2 \quad (5)$$

Table 4 below lists the adsorption rate constant 'b' calculated from the data for the paticular run and predicted from equations 3, 4 or 5 as indicated in the table.

Table 4

Correlation of Rate Constant 'b' with Relative Humidity

Observed and Predicted Results

Exhibit Number	Carbon Type	RH %	Data b	Predicted b
avg.1&2	ASC	22	0.239	0.2387[1]
3	ASC	45	0.271	0.2798[1]
4	ASC	45	0.287	0.2798[1]
6	ASC	59	0.269	0.268[1]
8	ASC	84	0.177	0.1777[1]
5(*)	ASC	45	0.479	0.4613[3]
7(*)	ASC	57	0.678	0.7254[3]
9(*)	ASC	85	0.434	0.487[3]
11(*)	ASC	80	0.691	0.6173[3]
14	BASE	59	0.1085	0.1083[2]
19	BASE	84	0.276	0.2341[2]
20	BASE	83	0.223	0.2379[2]
21	BASE	97	0.118	0.1187[2]

(*) Denotes Readsorption

[1] from Equation 4

[2] from Equation 3

[3] from Equation 5

Figures 4 through 9 graphically represent the observed and predicted data from selected water adsorption tests. These curves illustrate that the water adsorption rate is well described by the relationships applied. The lines in the figures represent the predicted rate using the rate constant obtained from the data of the individual tests. The diamond symbols represent the curve obtained when the rate constant predicted from the relative humidity relationship described by equations 3, 4 and 5 and the data in Table 4. The square symbols represent the actual percent adsorbed obtained at each time. The scales for each curve were selected to highlight differences between observed and predicted values.

Figure 4

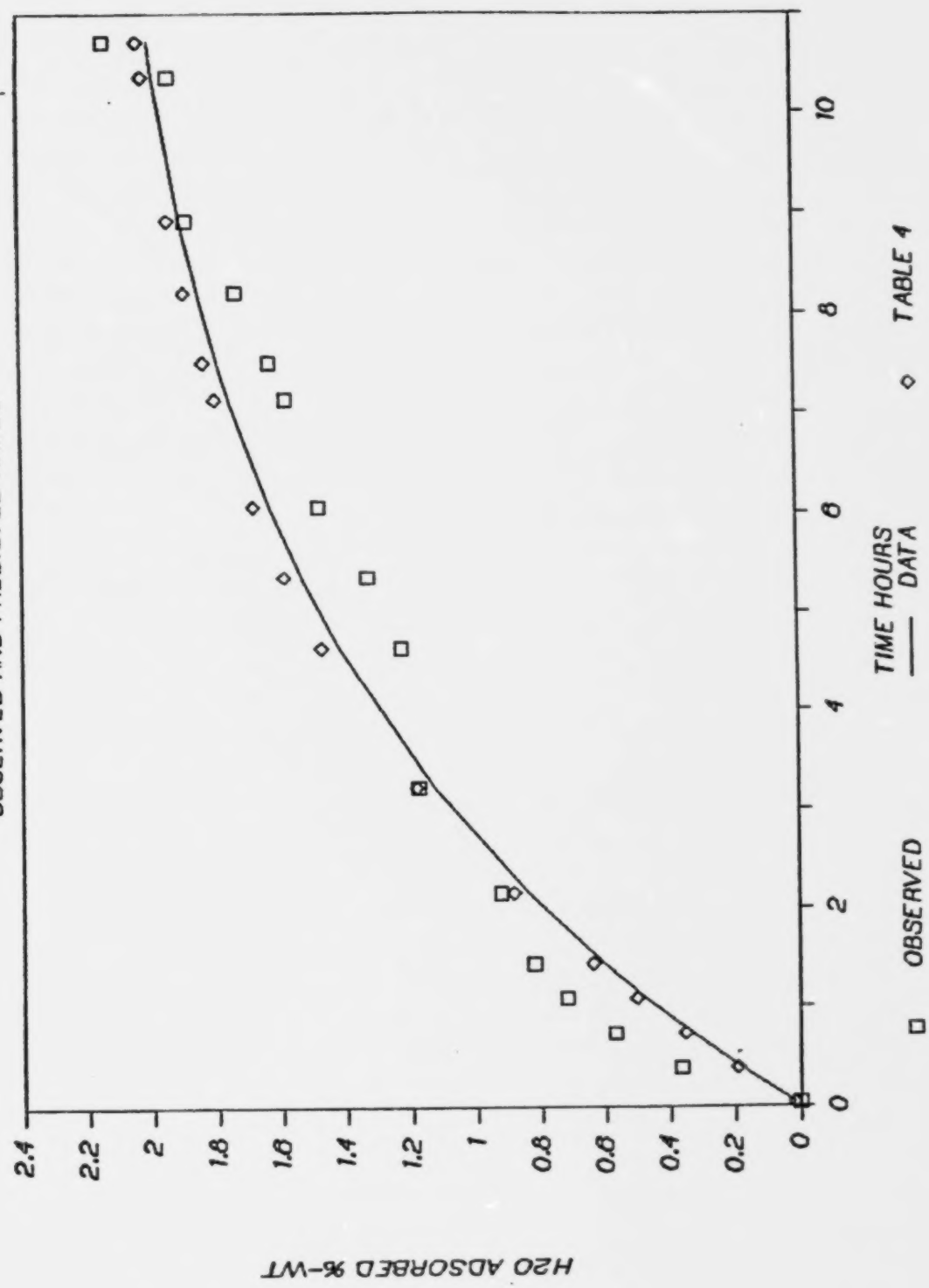
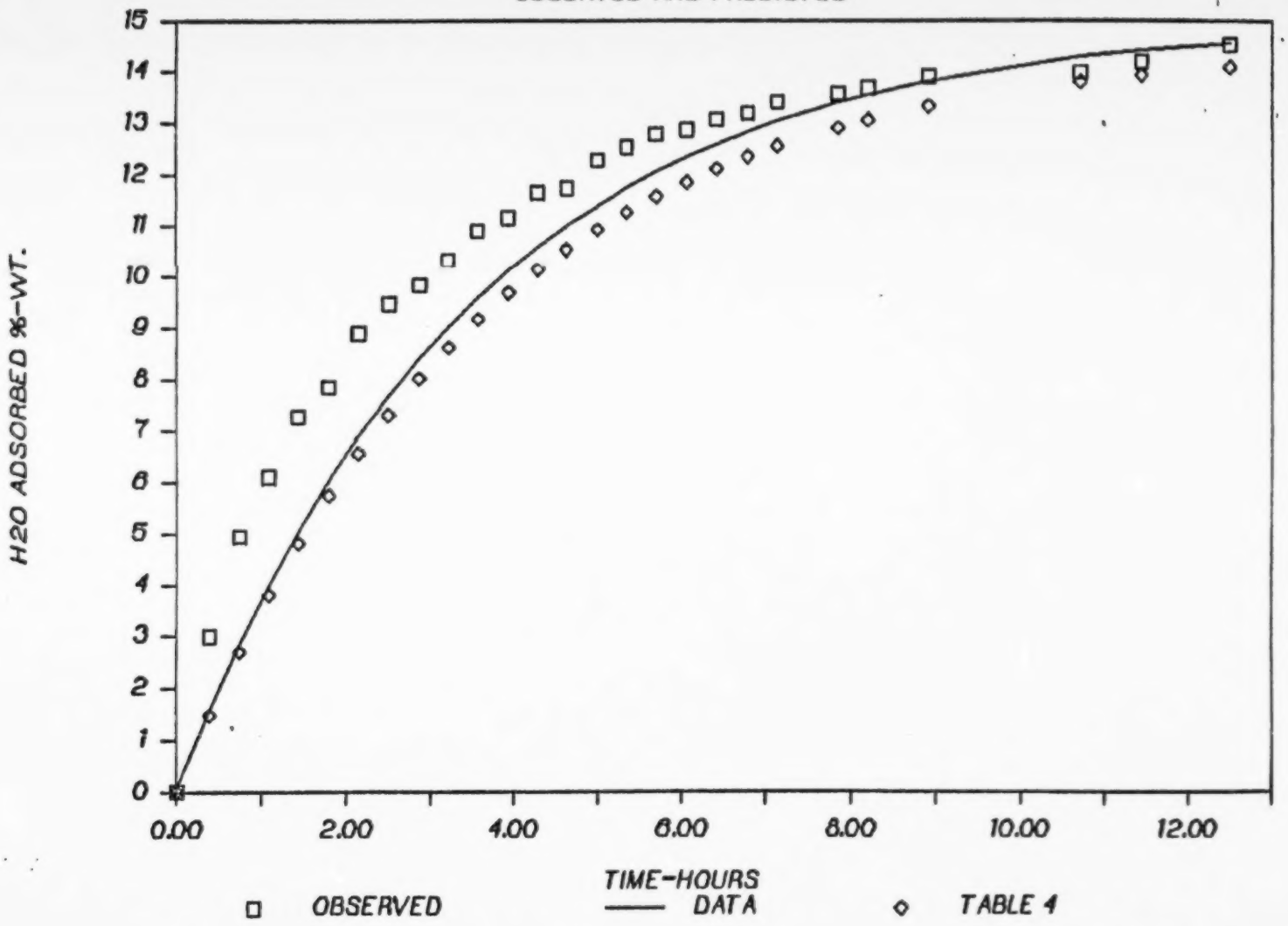

ASC H20 ADSORPTION 22 %RH
OBSERVED AND PREDICTED RATES
H2O ADSORBED %-WT
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
TIME HOURS
DATA
OBSERVED
TABLE 1

Figure 5

ASC ADSORPTION 45 %RH

OBSERVED AND PREDICTED

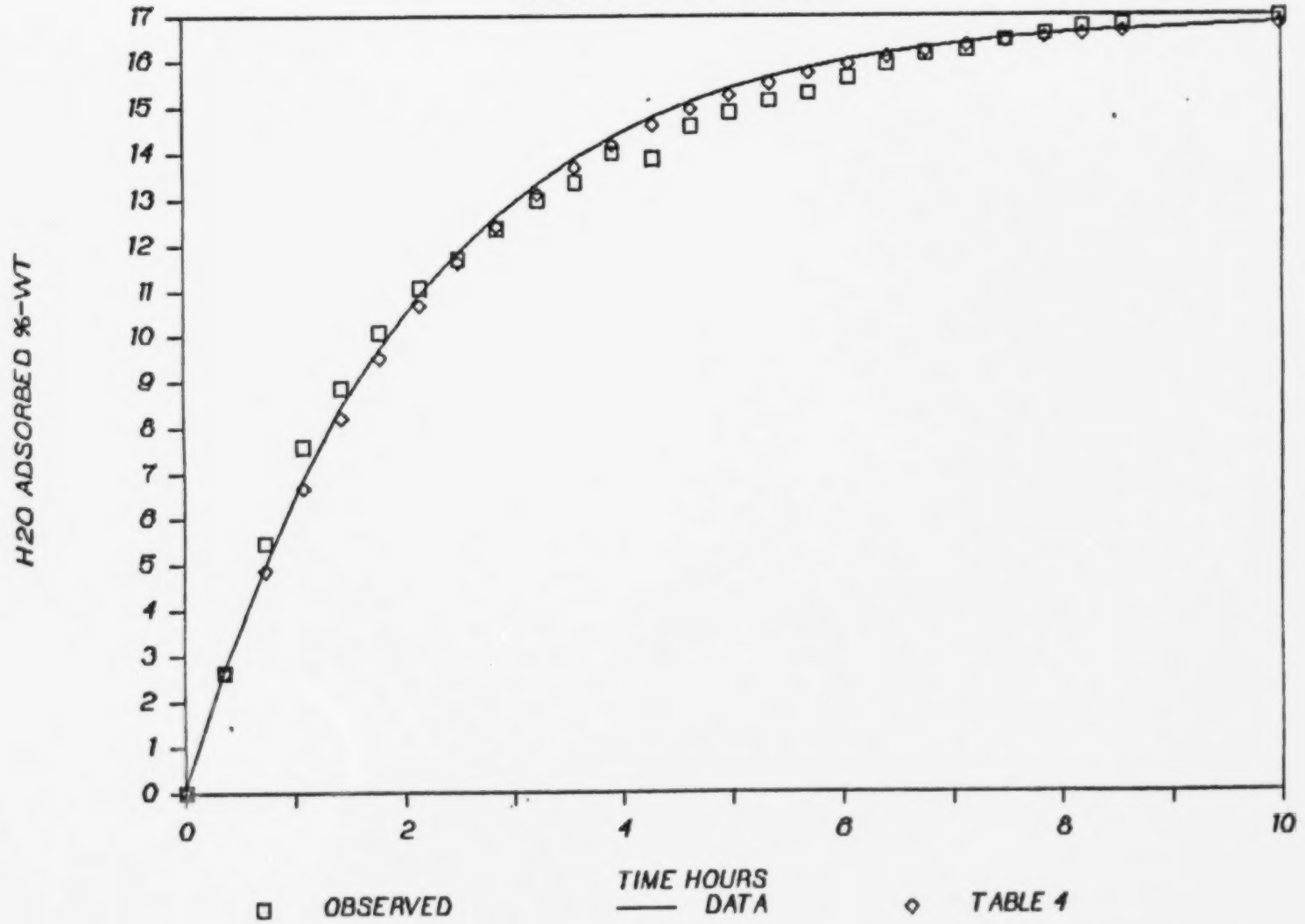


P148563.PDF [Page: 25 of 96]

P148563.PDF [Page: 26 of 96]

ASC H20 READSORPTION 45 %RH

OBSERVED AND PREDICTED



P148563.PDF [Page: 27 of 96]

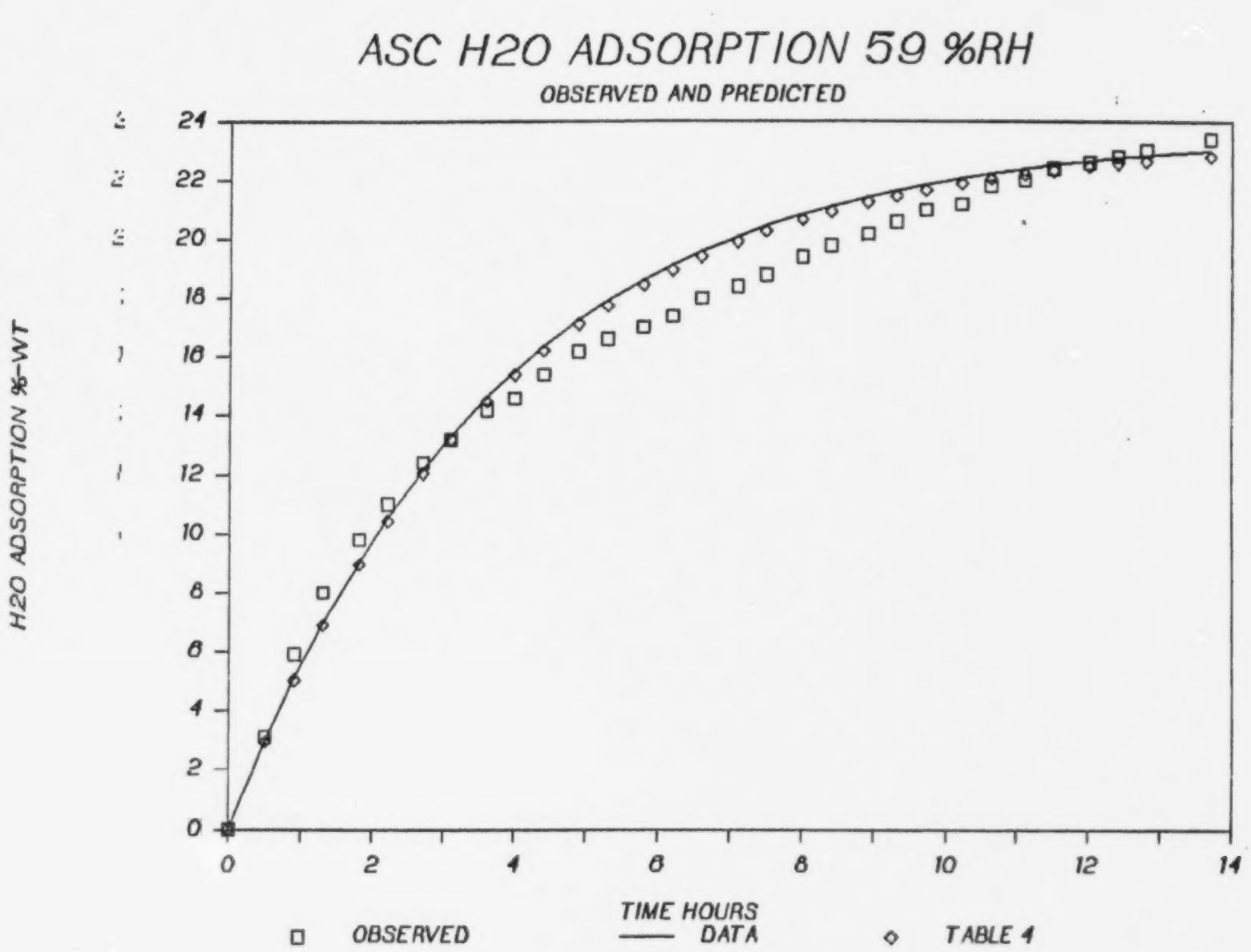
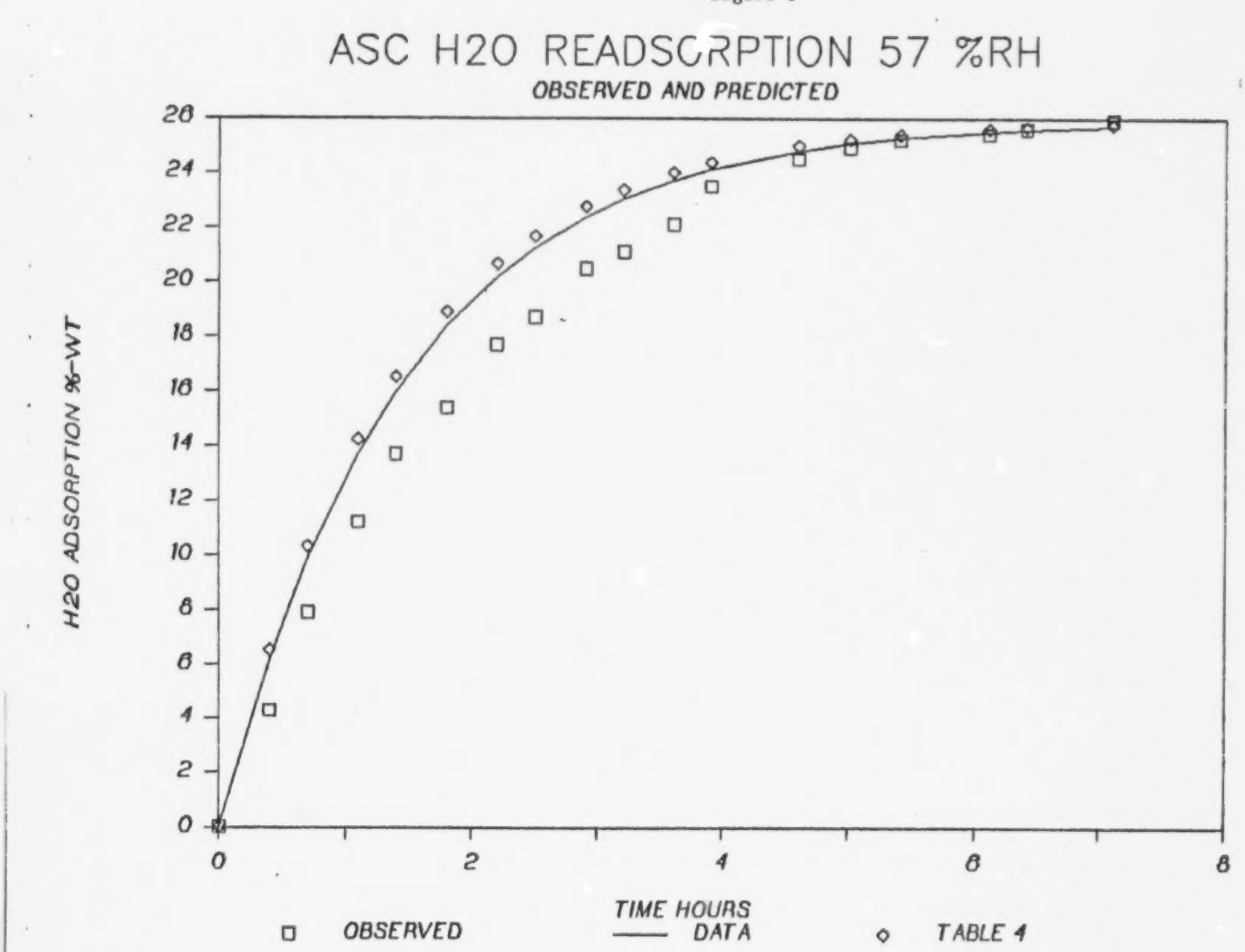
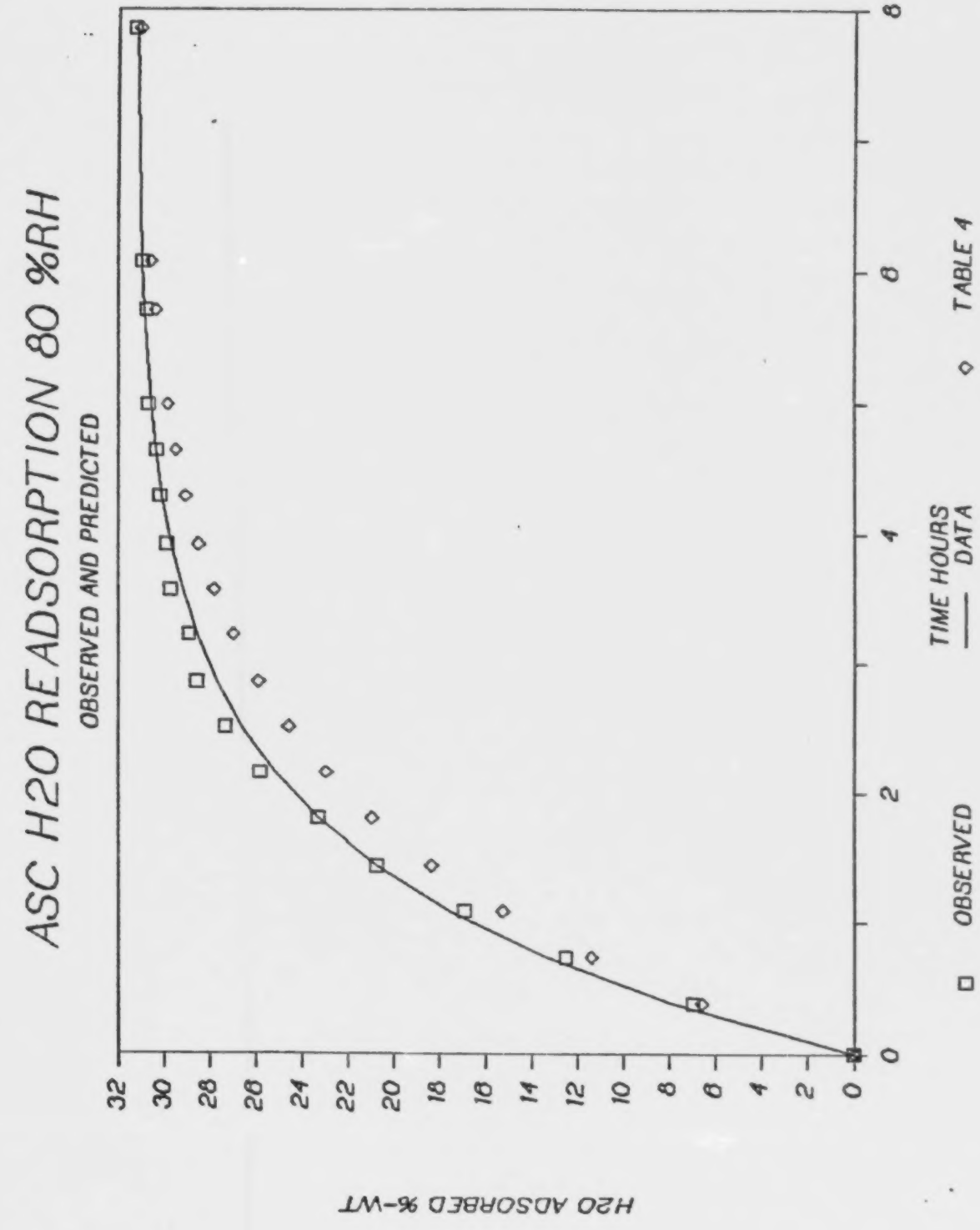


Figure 8



P148563.PDF [Page 28 of 96]


ASC H20 READSORPTION 80 %RH
OBSERVED AND PREDICTED
H20 ADSORBED %-WT
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
TIME HOURS
□ OBSERVED
— DATA
◇ TABLE 4

Figures 5 and 6 represent observed and predicted curves for initial adsorption and readsorption at 45% relative humidity on ASC carbon.

Figures 7 and 8 illustrate the differences between initial adsorption and readsorption at 57 to 59% RH.

Figures 10 through 12 show the base carbon curves, observed and predicted over a range of 60 to 97% relative humidity. There was insufficient data at lower relative humidities to warrant correlation of rate constant for readsorption with relative humidity. These curves illustrate reasonable success in predicting H_2O adsorption rate on the base carbon.

Water Desorption Rate -- The approach to desorption rate analysis was the same as that used for adsorption rate. In this case the rate of loss was used in equation 2 to obtain equation 6 below. 'L' is the % loss from

$$- \ln(1-L/Ws) = c + b_{des}t \qquad (6)$$

saturation. 'W_L' is the total loss. Using the desorption rate value, the 'b'_{des} curve for desorption can be represented by equation 7 below. 'W' is still the loading at time t. 'W_L' is the total loss and b_{des} is the slope obtained from equation 6.

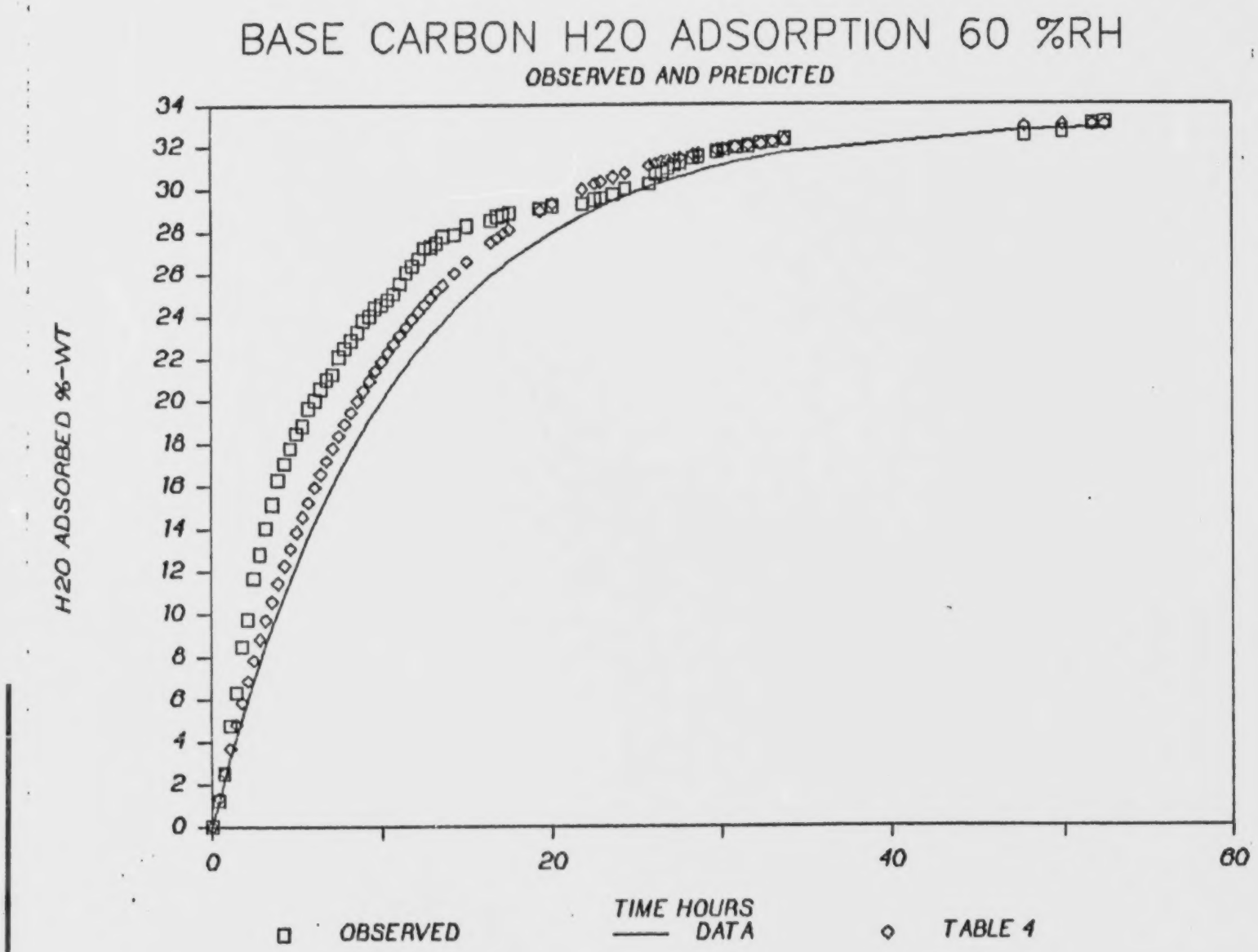
$$W = Ws-W_L(1-e^{-bt}) \qquad (7)$$

Table 5 below lists the desorption summary for ASC, the desorption rate constants and correlation coefficients. Table 6 lists the same data for base carbon desorption. The data in Table 5 were correlated with relative humidity and the equation for calculating the 'b' value for desorption for ASC is given in equation 8 below. Equation 9 for calculating the rate constant for desorption from base carbon is also listed.

$$b = 1.578 + 0.02305(RH) - 0.0004951(RH)^2 \qquad (8)$$

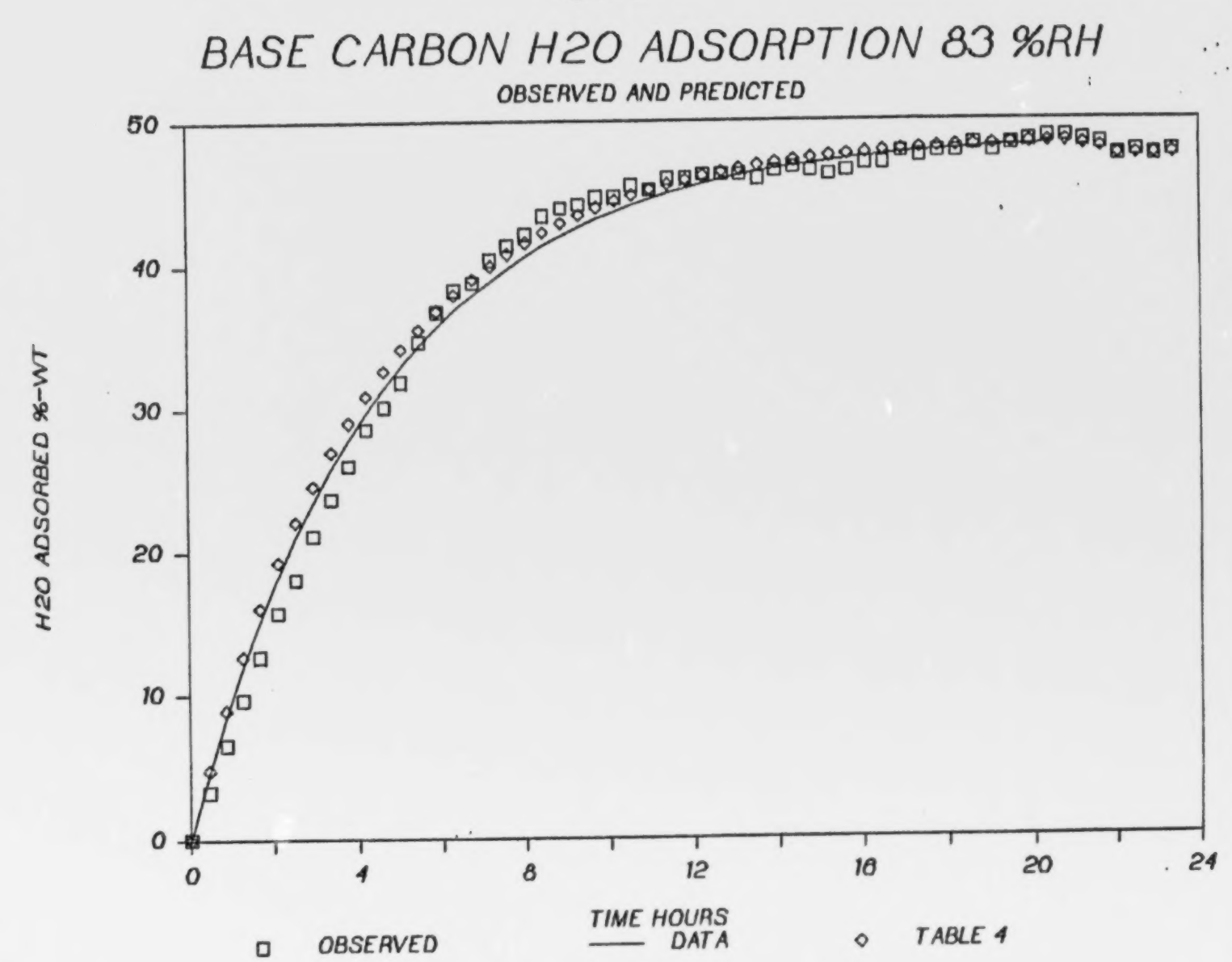
$$b = -2.0640 + 0.07448(RH) - .003830(RH)^2 \qquad (9)$$

Figure 10



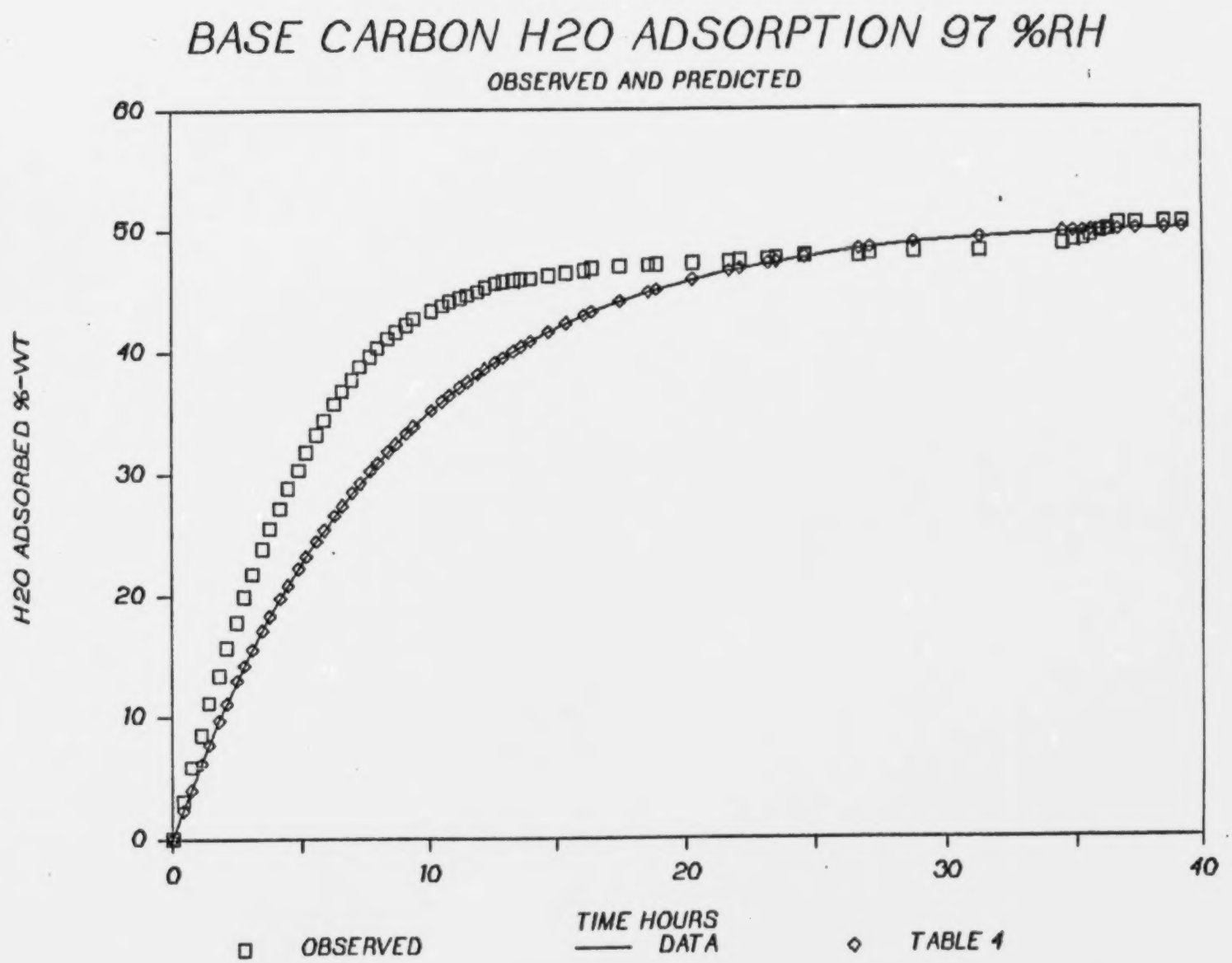
P148563.PDF [Page: 31 of 96]

Figure 11



P148563.PDF [Page: 32 of 96]

Figure 12



P148563.PDF [Page: 33 of 96]

Table 5

ASC Desorption Summary

Exhibit Number	Initial % RH	H_2O Desorbed % Wt.	Rate Constant b	Corr. C R
22	20	2.7	1.836	.831
23	45	16.5	1.635	.9
24	65	30.4	.957	.9
25	80	32.3	.266	.864

Table 6

Base Carbon Desorption Rate Summary

Exhibit Number	Initial % RH	H_2O Desorbed % Wt.	Rate Constant b	Corr. Coef. R^2
26	60	36.6	0.254	0.875
27	60	33.1	0.313	.888
28	62	37.1	0.339	.895
29	85	49.7	0.757	0.959

The validity of Equation 9 is in doubt due to the narrow range of relative humidity data available. Figures 13 through 16 show comparison curves for H_2O desorption for ASC from the observed data, the predicted data and the data from Table 5 for the relative humidity correlation.

Figures 17 through 19 show the same comparison for the base carbon desorption.

Figure 13

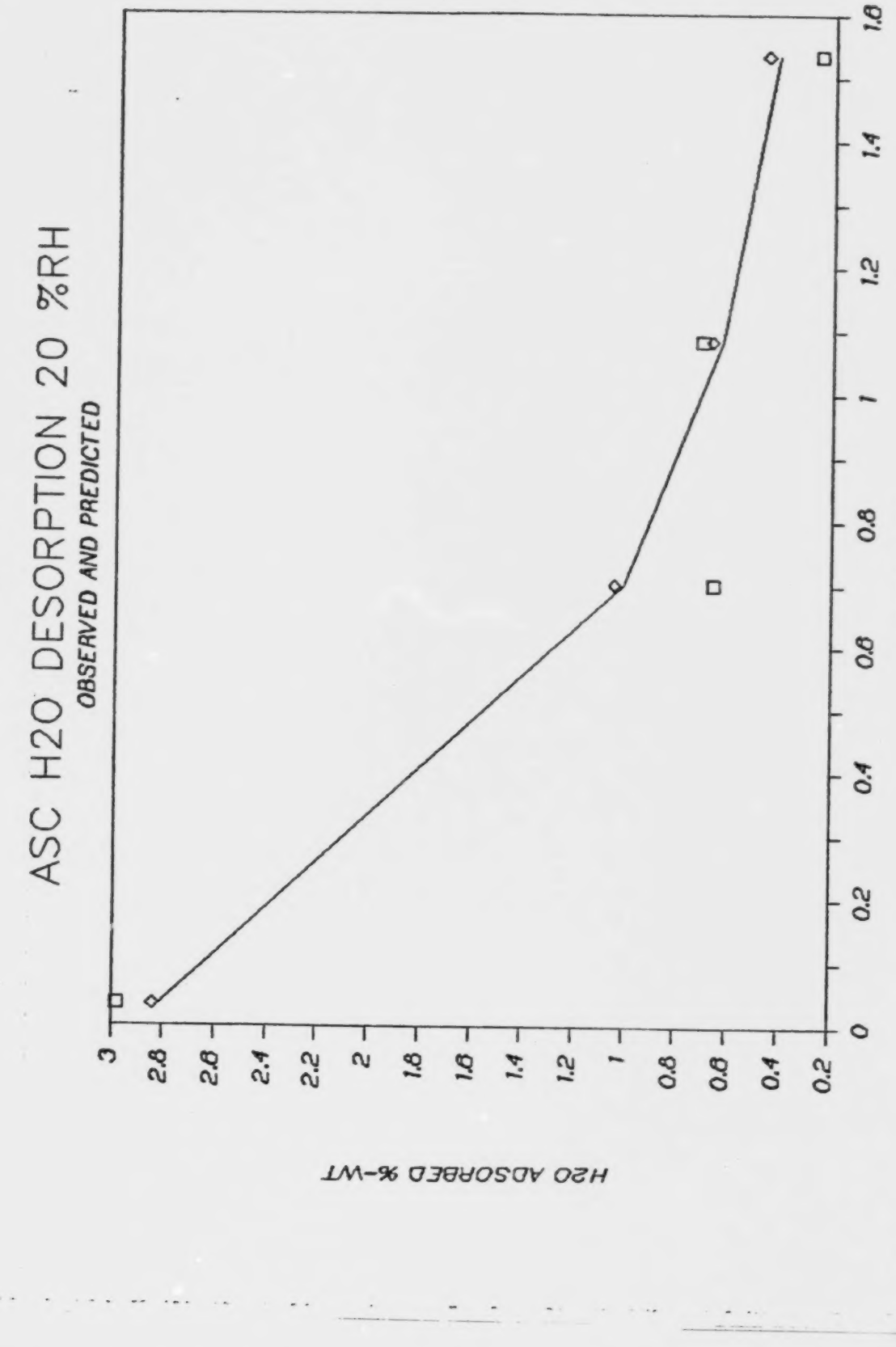

ASC H2O DESORPTION 20 %RH
OBSERVED AND PREDICTED
H2O ADSORBED %-WT
TIME HOURS
□ OBSERVED
—— DATA
◇ TABLE 5
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6

Figure 14

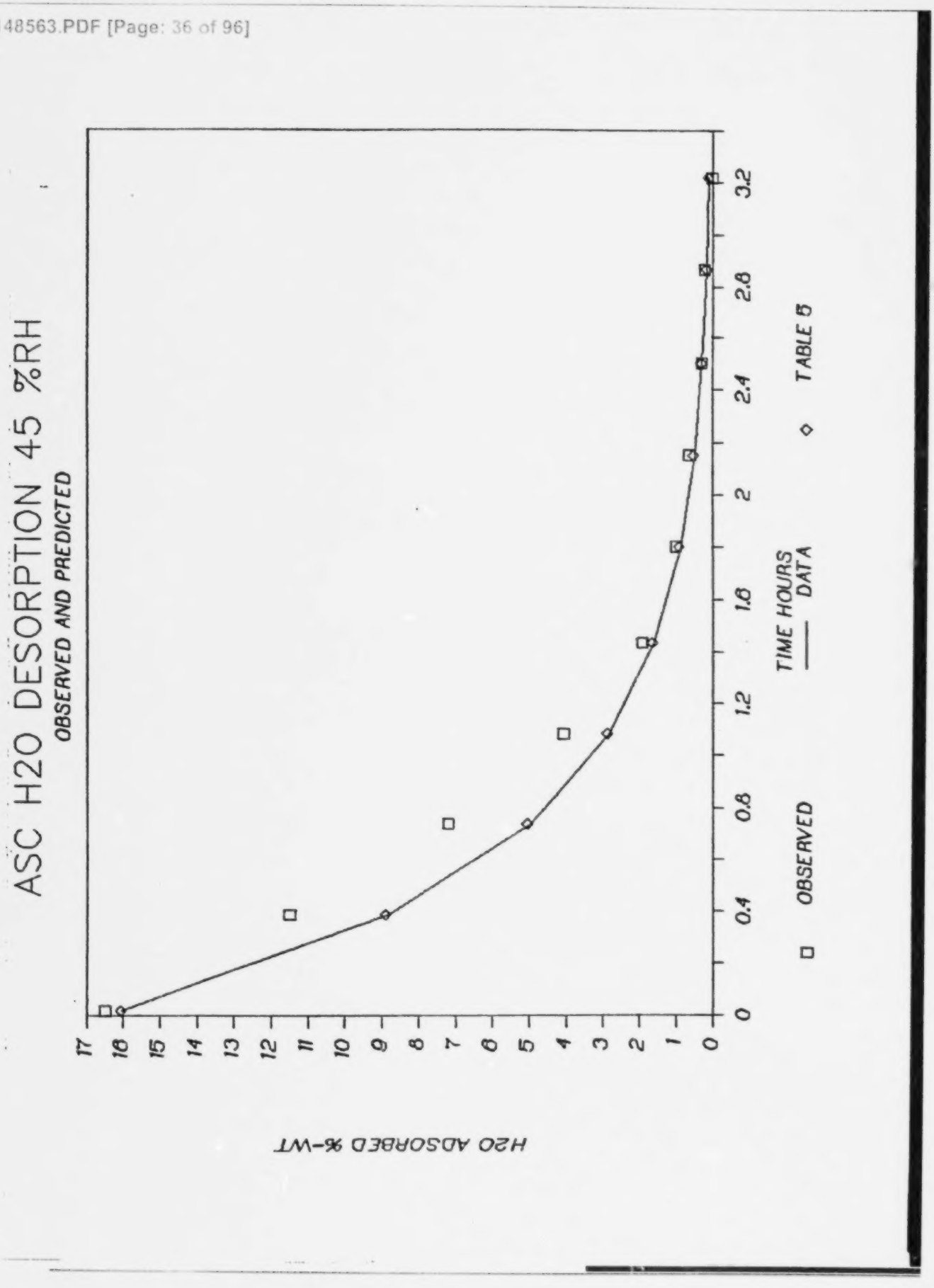
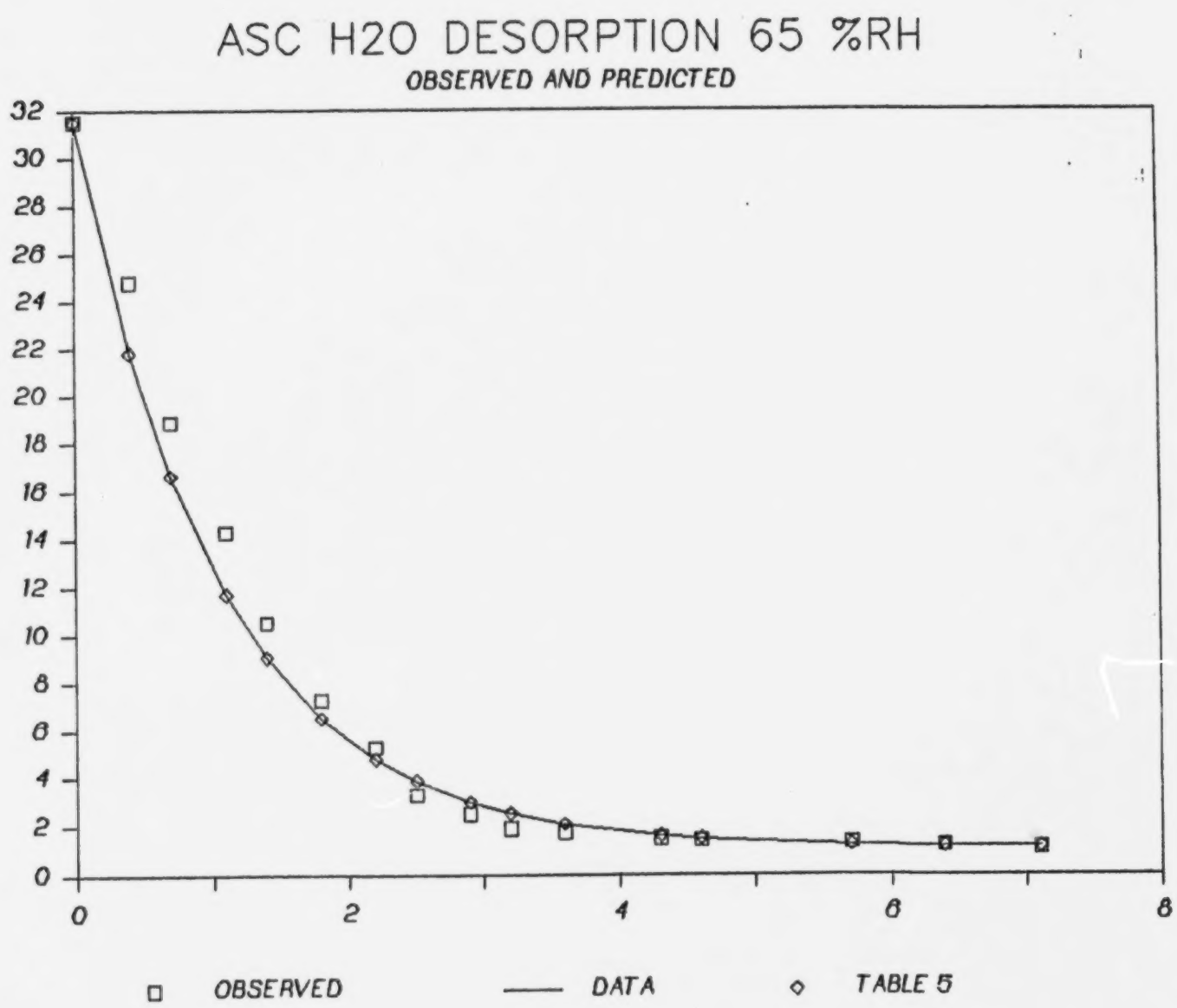

ASC H2O DESORPTION 45 %RH
OBSERVED AND PREDICTED
H2O ADSORBED %-WT
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
0
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
TIME HOURS
OBSERVED
DATA
TABLE 5

Figure 15

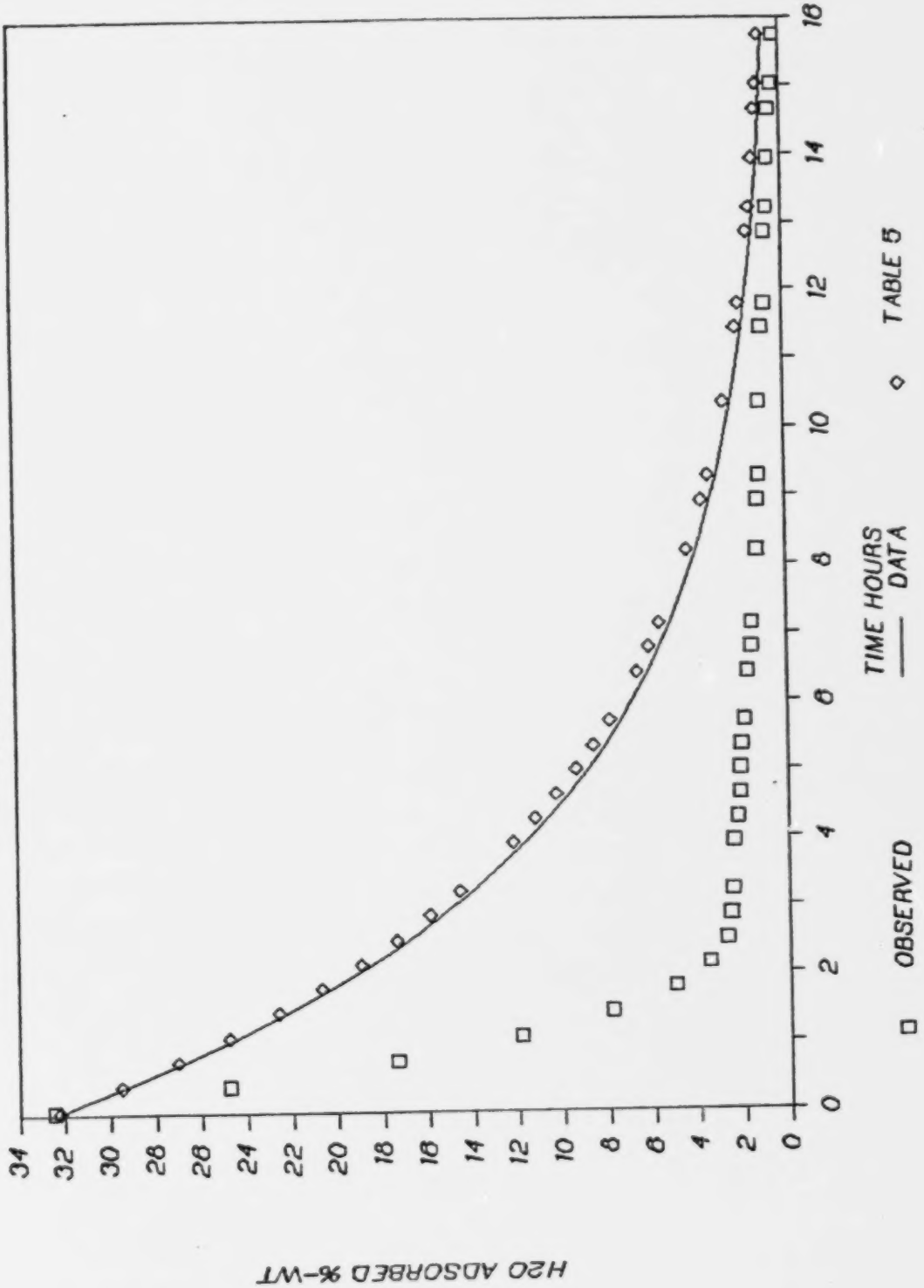


P148563.PDF [Page: 37 of 96]

Figure 16

ASC H2O DESORPTION 80 %RH

OBSERVED AND PREDICTED



In Figure 16 for ASC carbon desorption from 80% relative humidity the actual rate of desorption is more rapid than predicted by the model. At lower relative humidity levels the model predicts desorption behavior of ASC rather well. In Figures 17 and 18 the base carbon desorbs much faster than predicted while the 80% predicted curve is steeper than the observed rate. If extremely rapid moisture adsorption or desorption is encountered, a second order model might be useful. This model is illustrated in Equation 10.

$$W = (Ws/2)[(1-e^{-b_1 t})+(1-e^{b_2 t})] \qquad (10)$$

The model will account for rapid initial rate B_1 and take into account a second rate B_2 as steady state is approached.

The desorption rates for ASC (Table 5) at 20 and 45% RH are much more rapid than the adsorption rates at the b_{des} comparable relative humidity levels. At 65% and higher relative humidities the rate for adsorption and desorption are similar.

The base carbon rate of water desorption increased at 85% (Table 6), compared to adsorption rate (Table 3), while at 60 to 65% the rates are similar. However, the base carbon water adsorbed to equilibrium could be completely desorbed by dry air. This was not the case for ASC carbon.

Sequential Desorption -- Exhibits 30 through 34 are the data used to obtain the equilibrium data plotted in Figure 3. The rates of desorption from 95 to 40% relative humidity in increments of 20 relative humidity percentage points are essentially the same, but the apparent equilibrium value is higher than the value reached through adsorption at the same relative humidity. The rates of desorption are also much slower than the desorption rates in Table 5 for desorption with dry air.

The same phenomenon exists for the base carbon desorption data in Table 6 compared to data for partial desorption.

Figures 20 through 24 compare observed and predicted results for partical

Figure 17

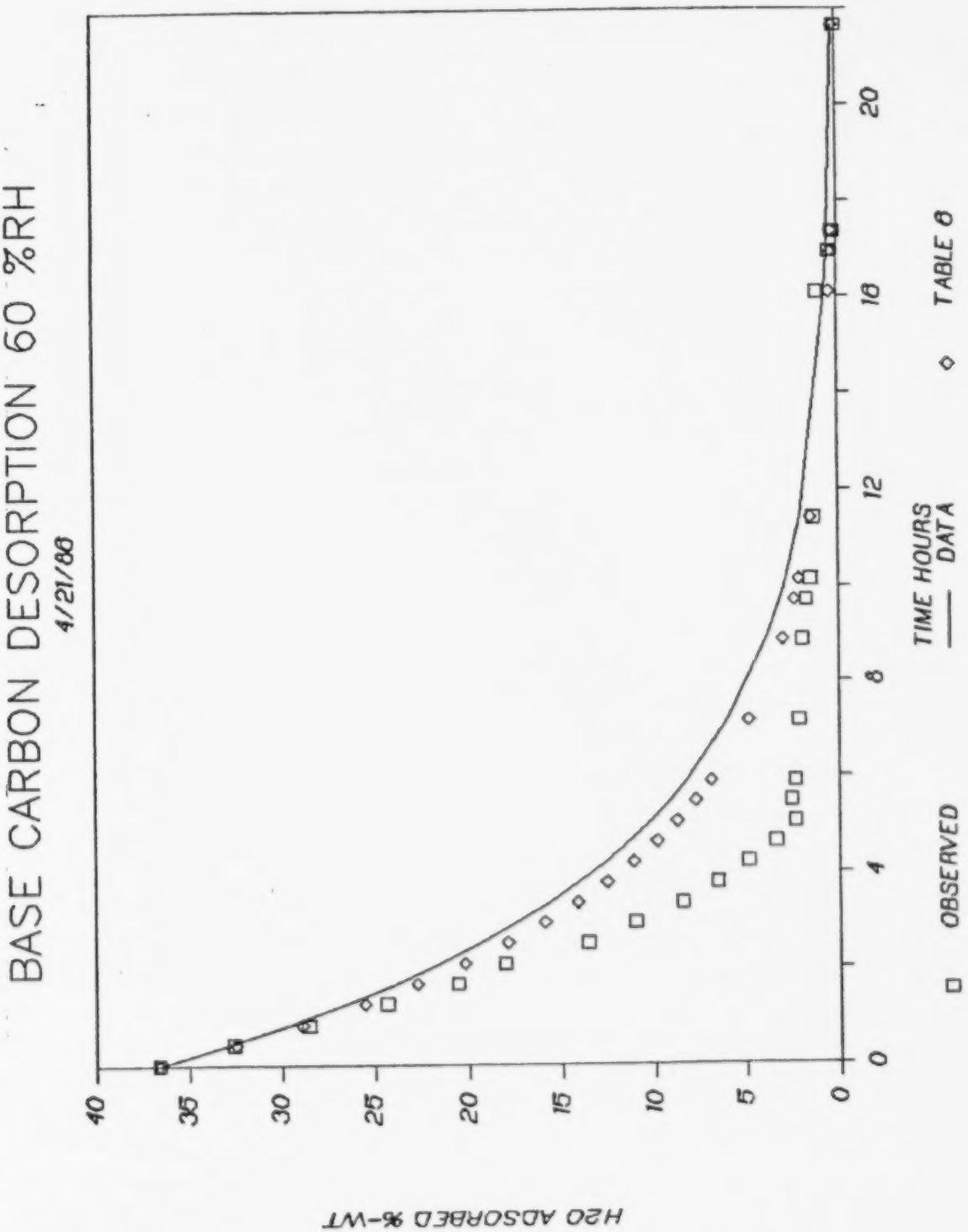

BASE CARBON DESORPTION 60 %RH
4/21/88
H2O ADSORBED %-WT
0
5
10
15
20
25
30
35
40
0
4
8
12
16
20
TIME HOURS
DATA
TABLE 8
OBSERVED

Figure 18

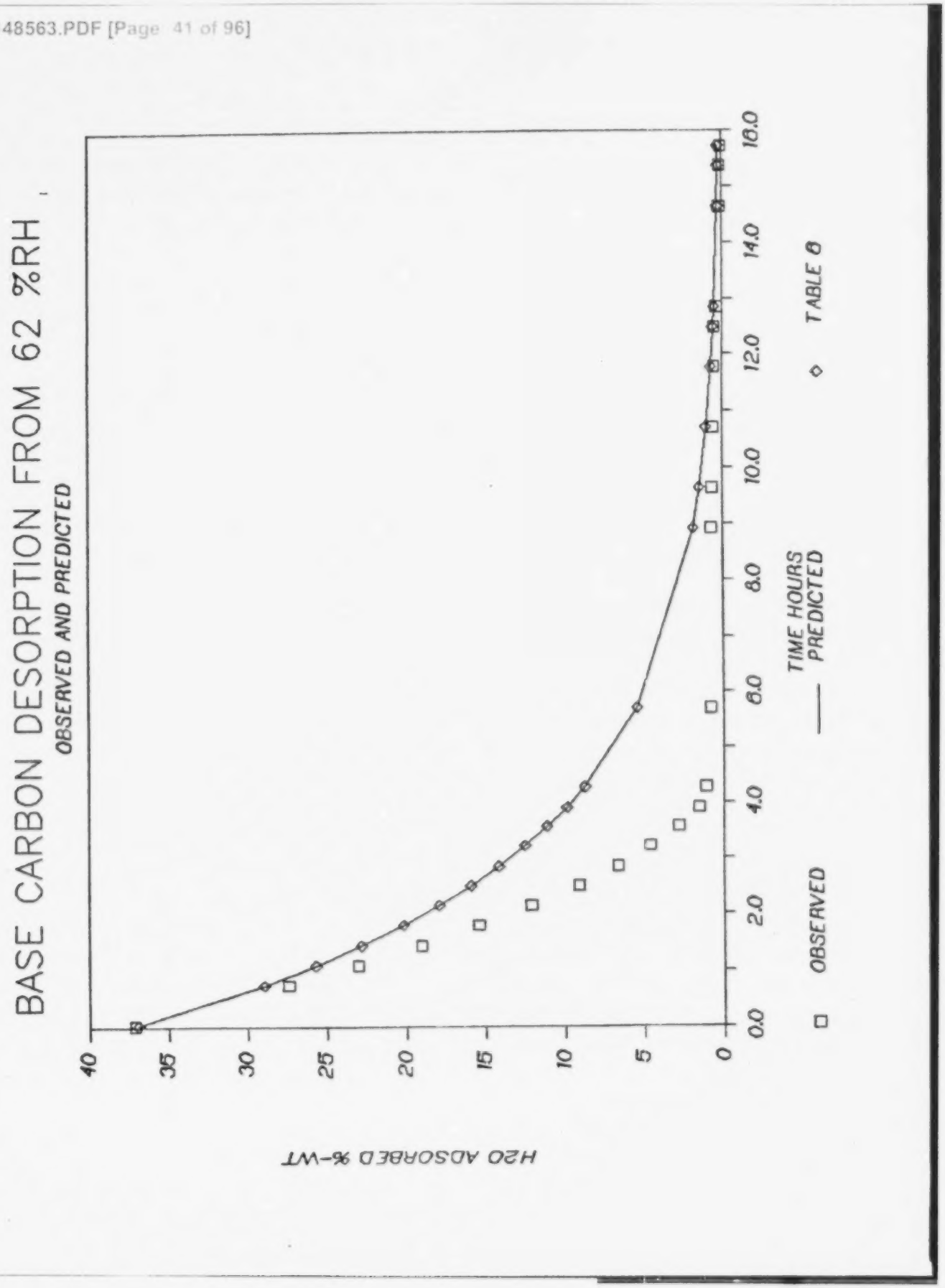

BASE CARBON DESORPTION FROM 62 %RH
OBSERVED AND PREDICTED
H2O ADSORBED %-WT
40
35
30
25
20
15
10
5
0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
TIME HOURS
PREDICTED
TABLE 6
OBSERVED

Figure 19

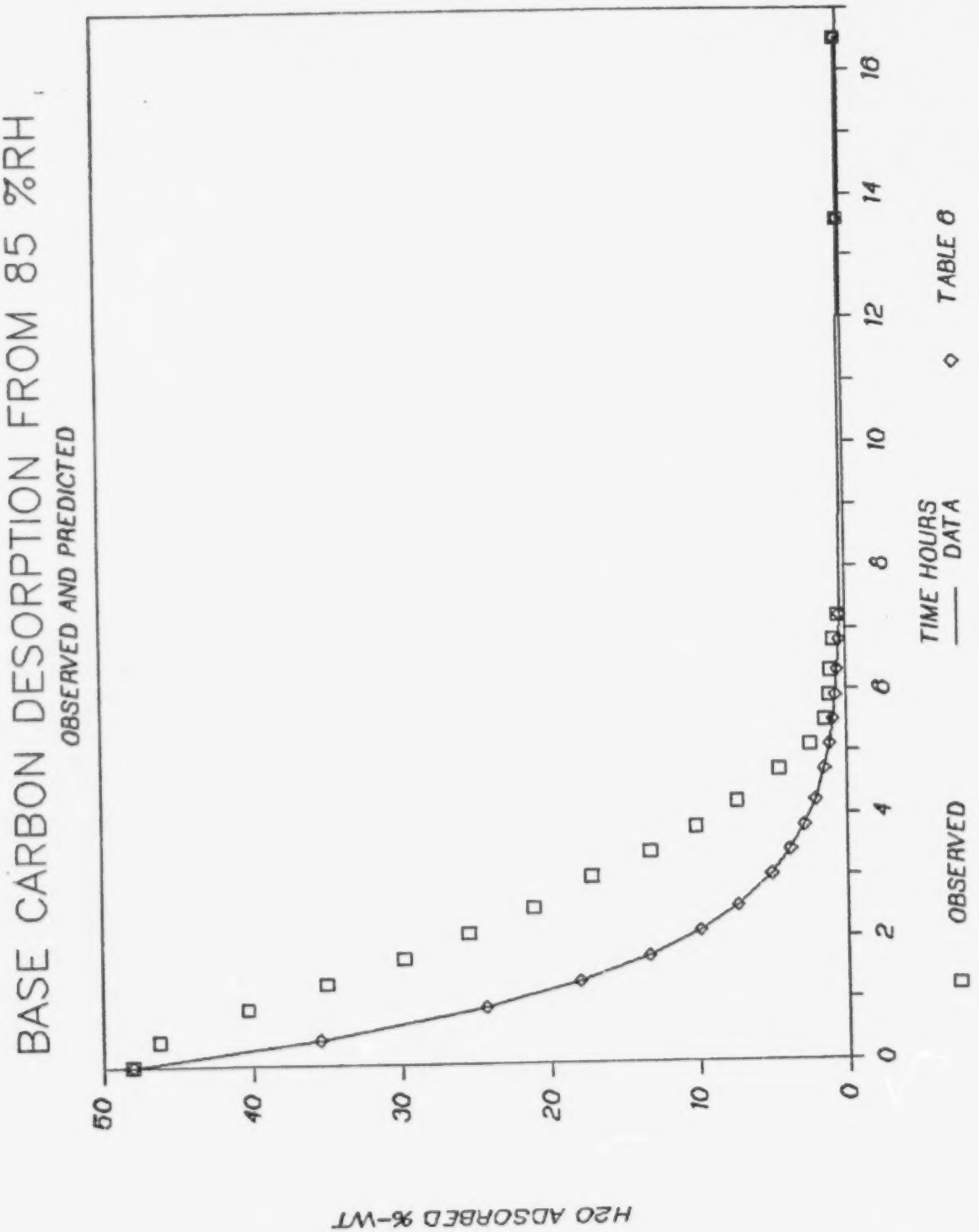
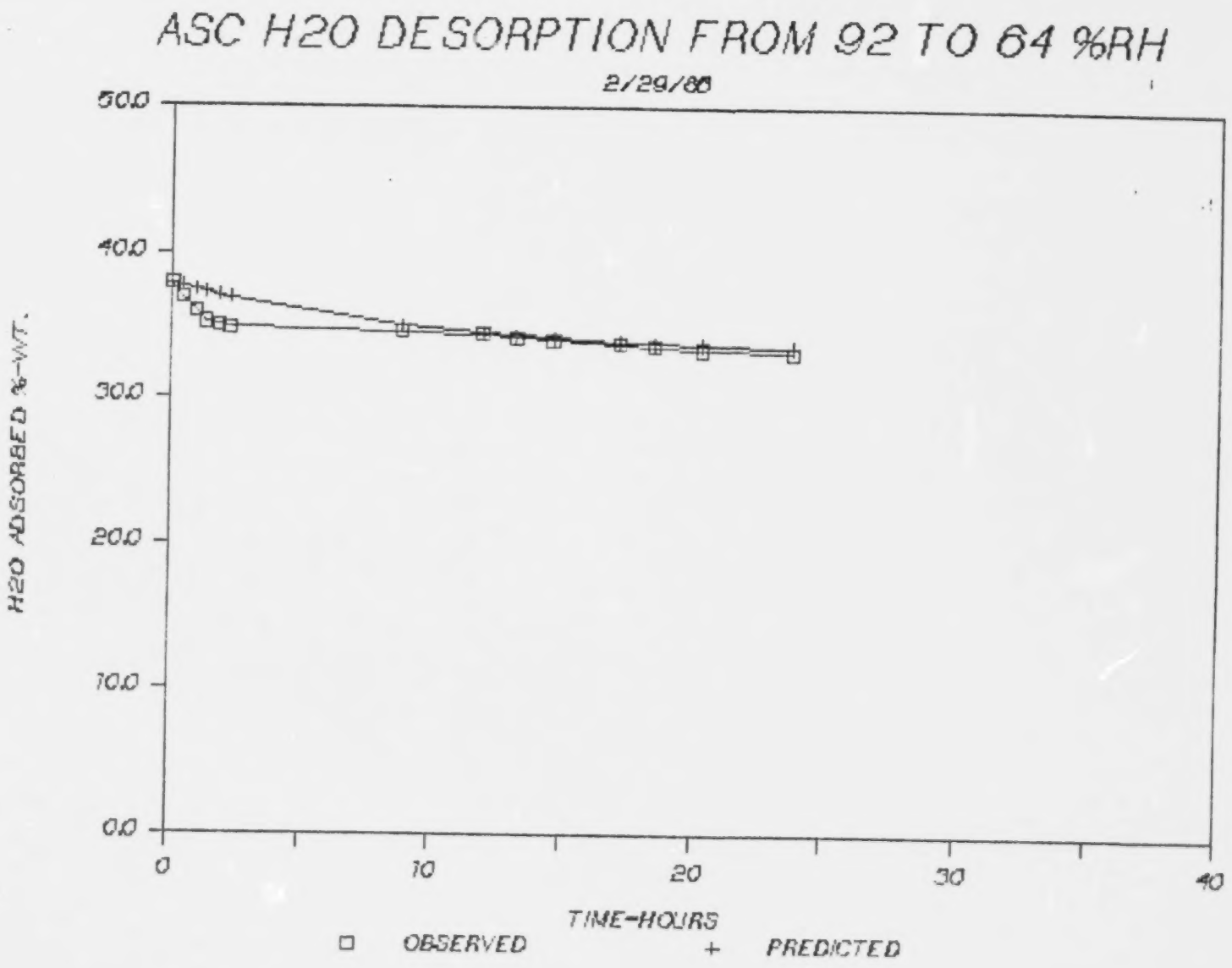
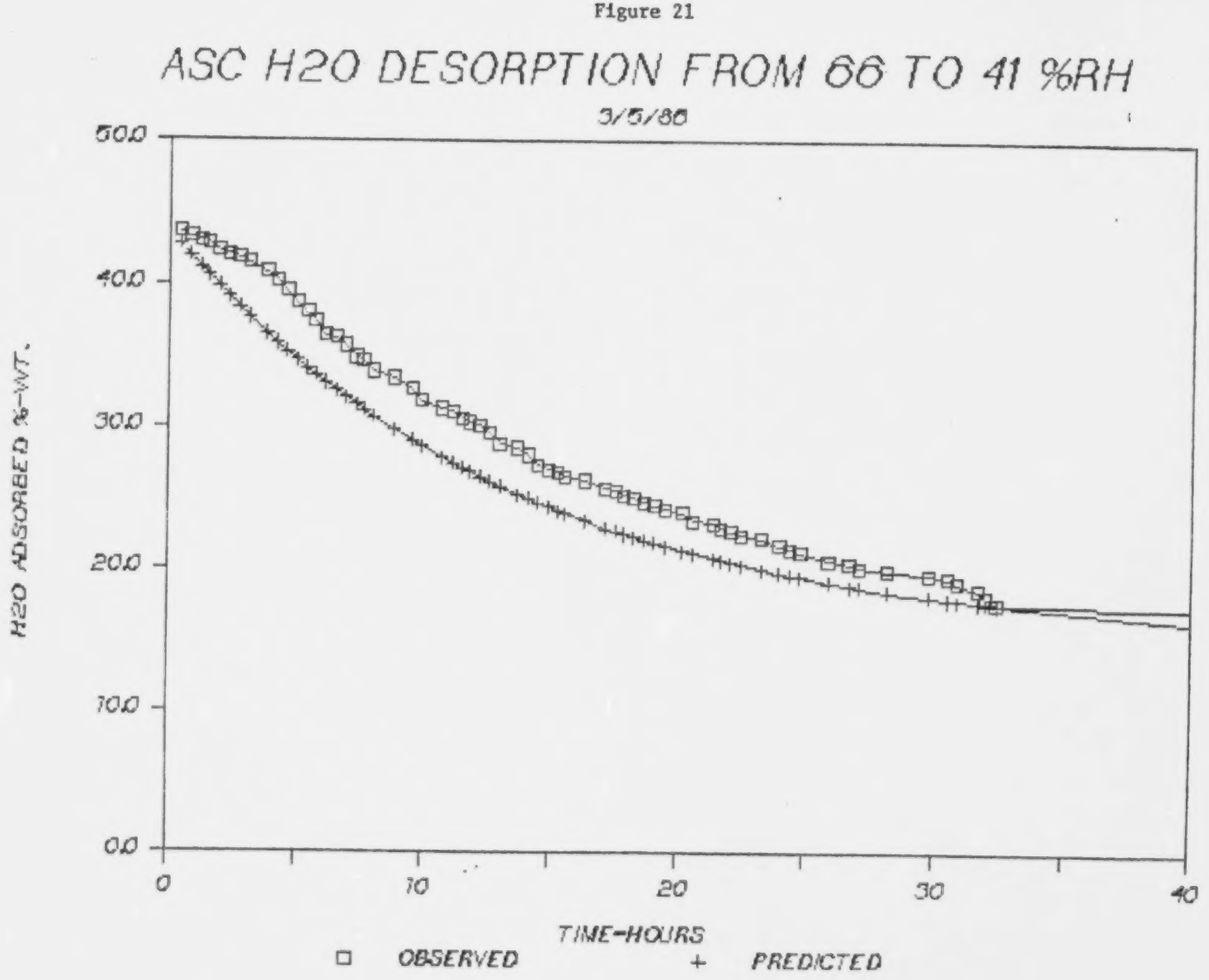

BASE CARBON DESORPTION FROM 85 %RH
OBSERVED AND PREDICTED
H2O ADSORBED %-WT
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
TIME HOURS
DATA
TABLE 6
OBSERVED

Figure 20



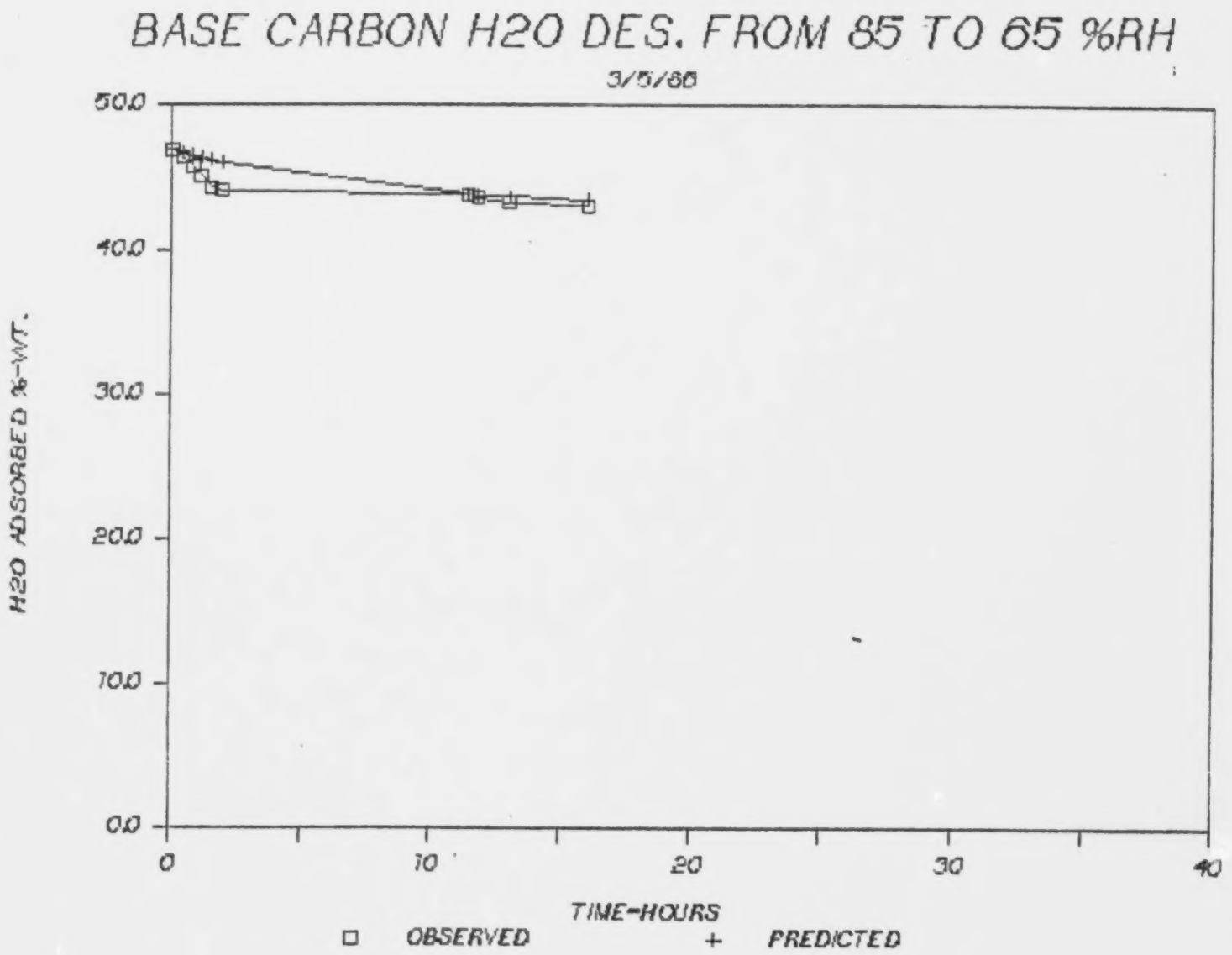
P148563.PDF [Page: 43 of 96]

Figure 21



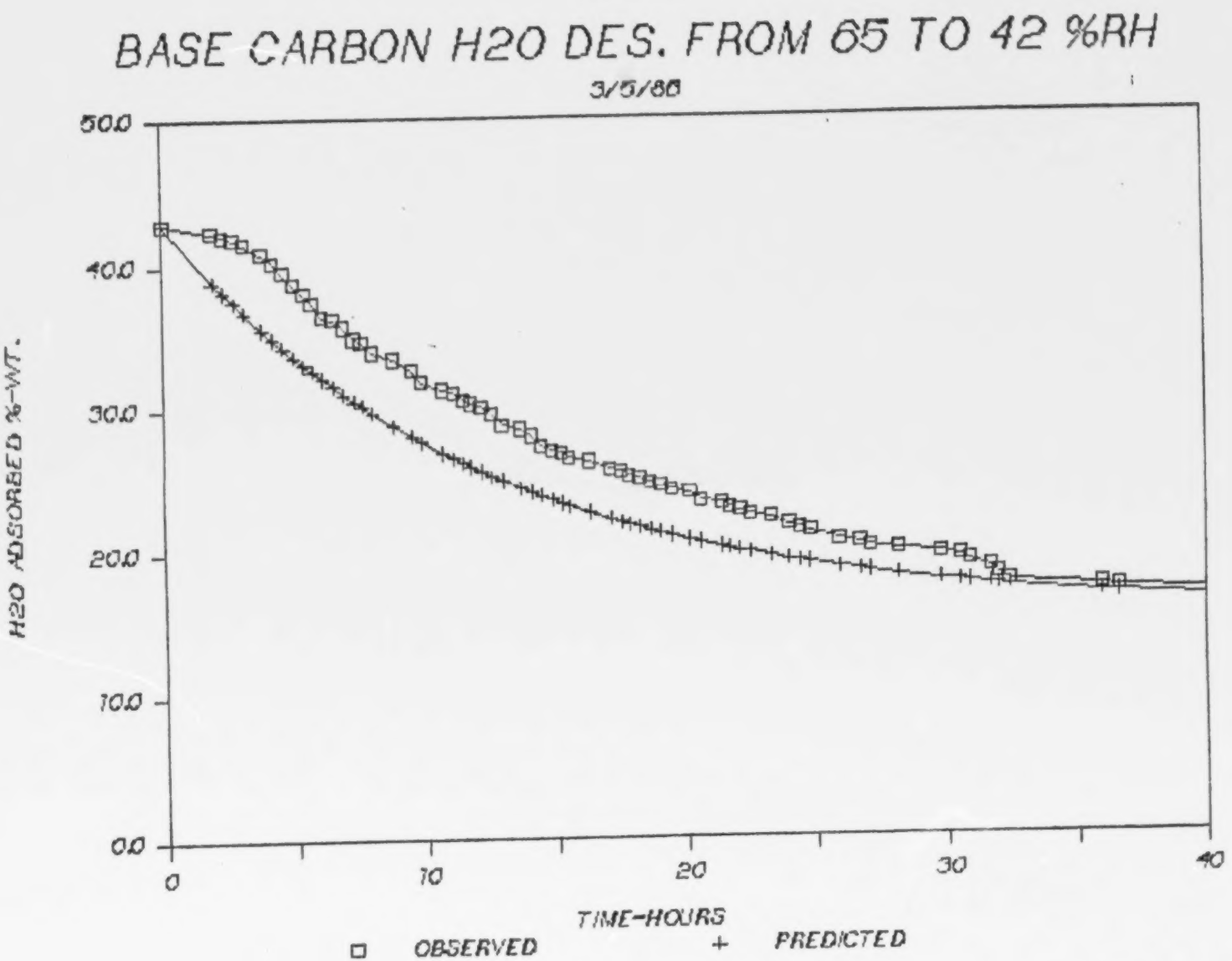
P148563.PDF [Page: 44 of 96]

Figure 22



P148563.PDF [Page: 45 of 96]

Figure 23



P148563.PDF [Page: 46 of 96]

desorption of water from ASC and the base carbon.

There is insufficient information to completely explain the reasons for the differences. It may be that the prolonged exposure to air during the sequential desorption period altered the surface of the carbon by chemical bonding or oxidation. The scope of this investigation would need to be broadened in order to explain this phenomenon.

From a practical standpoint the investigation has shown that ASC carbon should be protected from moisture before use. At relative humidities above 40%, the ASC carbon will pick up significant amounts of water. The amount of water picked up at a given time can be calculated using the rates determined in these experiments and the relationships between the rates and relative humidity derived and demonstrated here. As explained in the experimental section 0.2 - 0.4g (0.4 to 0.8 ml) of carbon was used in the experiments in a flowing humid air environment. The average sample size was approximately 0.3g. Therefore, for a given canister the maximum amount of moisture adsorbed for time of exposure at given RH can be estimated as follows:

- Calculate the adsorption rate "b" from equation 3 for the given RH.
- Divide 'b' by 3 times the weight of the carbon in grams contained in the canister.
- Insert the appropriate equilibrium moisture pickup for the relative humidity, the calculated 'b' value and the time of exposure into equation 1 to determine the amount of water picked up for the given exposure.

Another finding of these studies is that it may be possible to desorb moisture from a canister if a source of dry air is available.

However, moisture previously adsorbed cannot be efficiently desorbed by using humid air at a lower relatively humidity than that encountered in use.

APPENDIX A

EXHIBIT 1

ASC H2O-ADSORPTION 21 %RH 4/14/86

RATE CONSTANT 0.2615

REGRESSION COEFF R^2=0.79363

TIME	LOAD	RH	BETA	b DATA	b TABLE 4
0.0	0.0	5.8	0.0	0.0	0.0
0.4	0.9	21.0	0.4	0.2	0.2
0.9	1.3	21.5	0.7	0.5	0.5
1.3	1.8	21.7	1.3	0.7	0.7
1.7	2.0	21.3	1.6	0.9	0.8
5.9	2.1	20.7	1.8	2.0	1.9
7.6	2.3	21.6	2.5	2.2	2.1
21.6	2.5	21.4		2.5	2.5

EXHIBIT 2

ASC H2O ADSORPTION 22 %RH 6/19/86

TIME	LOAD	RH	BETA	b DATA	b TABLE	RATE CONSTANT 0.2231 4REGRESSION COEFF R^2=0.844849
0.0	0.0	22.9	0.0	0.0	0.0	
0.4	0.4	23.0	0.2	0.2	0.2	
0.7	0.6	23.1	0.3	0.3	0.4	
1.1	0.7	23.1	0.4	0.5	0.5	
1.4	0.8	23.2	0.5	0.6	0.6	
2.2	0.9	23.2	0.5	0.8	0.9	
3.2	1.2	23.1	0.8	1.1	1.2	
4.6	1.2	23.2	0.8	1.4	1.5	
5.4	1.3	23.4	0.9	1.5	1.6	
6.1	1.5	23.5	1.1	1.6	1.7	
7.1	1.6	22.3	1.3	1.8	1.8	
7.5	1.6	23.6	1.3	1.8	1.8	
8.2	1.7	23.6	1.5	1.8	1.9	
8.9	1.9	22.3	1.9	1.9	1.9	
10.4	1.9	23.6	2.1	2.0	2.0	
10.7	2.1	23.6	3.5	2.0	2.0	
11.8	2.2	22.4		2.0	2.1	

P148563.PDF [Page: 51 of 96]

EXHIBIT 3

ASC H2O ADSORPTION 45 %RH 4/9/86

TIME	LOAD	RH	BETA DATA	TABLE 4	
0.0	0.0	7.1	0.0	0.0	0.0
0.4	1.2	41.8	0.1	1.6	1.6
0.9	3.0	46.2	0.2	3.3	3.3
1.3	4.7	45.6	0.4	4.5	4.5
1.7	5.8	45.2	0.5	5.6	5.6
2.1	6.3	45.3	0.5	6.6	6.6
2.5	7.1	45.4	0.6	7.4	7.4
3.0	7.8	45.7	0.7	8.4	8.4
3.4	8.7	45.9	0.9	9.1	9.1
4.2	9.2	45.8	0.9	10.3	10.3
4.7	10.4	45.7	1.2	10.9	10.9
5.1	11.0	45.6	1.3	11.3	11.3
5.5	11.3	45.7	1.4	11.7	11.7
5.9	11.5	45.8	1.4	12.0	12.0
6.3	11.8	45.1	1.5	12.4	12.4
7.2	12.7	44.7	1.8	13.0	13.0
7.6	12.9	44.4	1.9	13.2	13.2
8.9	13.2	46.5	2.1	13.7	13.7
10.6	13.9	45.7	2.5	14.2	14.2
11.4	14.4	45.4	3.1	14.4	14.4
12.7	14.8	45.1	3.9	14.6	14.6
13.6	15.1	45		14.7	14.7

b=0.271
R^2=0.9

EXHIBIT 4

ASC H2O ADSORPTION AT 45 %RH 6/17/86

TIME	LOAD	RH	BETA	b DATA	b TABLE 4
0.0	0.0	20.7	0.0	0.1	0.0
0.4	3.0	43.3	0.2	1.6	1.5
0.7	4.9	44.2	0.4	2.8	2.7
1.1	6.1	44.6	0.5	4.0	3.8
1.4	7.3	44.7	0.7	5.0	4.8
1.8	7.9	44.8	0.7	6.0	5.7
2.2	8.9	44.8	0.9	6.9	6.6
2.5	9.5	44.7	1.0	7.7	7.3
2.9	9.8	44.6	1.1	8.4	8.0
3.2	10.3	44.5	1.2	9.0	8.6
3.6	10.9	44.6	1.3	9.6	9.2
3.9	11.2	44.6	1.4	10.1	9.7
4.3	11.7	44.6	1.5	10.6	10.1
4.6	11.7	44.5	1.5	11.0	10.6
5.0	12.3	44.6	1.7	11.4	10.9
5.4	12.5	44.6	1.8	11.8	11.3
5.7	12.8	44.7	1.9	12.1	11.6
6.1	12.9	44.8	2.0	12.4	11.9
6.4	13.1	44.8	2.1	12.6	12.1
6.8	13.2	44.9	2.1	12.8	12.3
7.1	13.4	44.9	2.3	13.0	12.6
7.9	13.6	45.0	2.4	13.4	12.9
8.2	13.7	44.8	2.5	13.6	13.1
8.9	13.9	44.8	2.6	13.8	13.3
10.7	14.0	45.3	2.7	14.3	13.8
11.4	14.2	45.3	2.9	14.4	13.9
12.5	14.5	45.7	3.5	14.6	14.1

RATE CONSTANT=.286757

CORRELATION COEFF R^2=.93806

EXHIBIT 5

ASC H2O READSORPTION 45 %RH 6/18/86

TIME	LOAD	RH	BETA	b DATA	b TABLE	4RATE CONSTANT=0.479372
0.0	0.0	6.2	0.0	0.1	0.0	CORRELATION COEFF R^2=0.969324
0.4	2.6	38.8	0.2	2.7	2.6	
0.7	5.5	41.6	0.4	5.0	4.9	
1.1	7.6	42.5	0.6	6.9	6.7	
1.4	8.8	42.9	0.7	8.4	8.2	
1.8	10.1	43.1	0.9	9.7	9.5	
2.2	11.0	43.2	1.1	10.9	10.7	
2.5	11.7	43.2	1.2	11.8	11.6	
2.9	12.4	43.2	1.3	12.6	12.4	
3.2	13.0	43.1	1.5	13.3	13.1	
3.6	13.4	43.1	1.6	13.9	13.7	
3.9	14.0	43.3	1.7	14.4	14.2	
4.3	13.9	43.5	1.7	14.8	14.6	
4.6	14.6	43.7	2.0	15.1	15.0	
5.0	14.9	44.0	2.1	15.4	15.3	
5.4	15.1	44.4	2.2	15.7	15.5	
5.7	15.3	44.6	2.3	15.9	15.7	
6.1	15.6	44.9	2.6	16.0	15.9	
6.4	15.9	45.0	2.8	16.2	16.1	
6.8	16.2	45.1	3.1	16.3	16.2	
7.1	16.2	45.3	3.2	16.4	16.3	
7.5	16.5	45.3	3.5	16.5	16.4	
7.9	16.6	45.3	3.8	16.6	16.5	
8.2	16.7	45.3	4.4	16.6	16.6	
8.6	16.8	45.3	4.6	16.7	16.6	
10.0	17.0	45.2	ERR	16.8	16.8	

EXHIBIT 6

ASC H2O ADSORPTION 59%RH 3/21/86

TIME	LOAD	RH	BETA	b DATA	b TABLE 4	RATE CONSTANT b=0.268511
0.0	0.0	4.2	0.0	0.0	0.0	CORRELATION COEFF R^2=0.928208
0.5	3.1	63.8	0.1	3.0	2.9	
0.9	5.9	64.6	0.3	5.1	5.0	
1.3	8.0	64.9	0.4	7.0	6.9	
1.8	9.8	64.2	0.5	9.0	9.0	
2.2	11.0	65.2	0.6	10.5	10.4	
2.7	12.4	63.8	0.7	12.2	12.1	
3.1	13.2	62.6	0.8	13.3	13.2	
3.6	14.2	61.7	0.9	14.6	14.5	
4.0	14.6	60.8	1.0	15.5	15.4	
4.4	15.4	60.1	1.1	16.4	16.2	
4.9	16.2	59.3	1.2	17.3	17.1	
5.3	16.6	58.7	1.2	17.9	17.7	
5.8	17.0	58.2	1.3	18.6	18.5	
6.2	17.4	57.9	1.3	19.1	19.0	
6.6	18	57.7	1.4	19.6	19.4	
7.1	18.4	57.6	1.5	20.1	19.9	
7.5	18.8	57.6	1.6	20.4	20.3	
8	19.4	57.7	1.7	20.8	20.7	
8.4	19.8	57.7	1.8	21.1	20.9	
8.9	20.2	57.8	1.9	21.4	21.2	
9.3	20.6	57.8	2.1	21.7	21.5	
9.7	21	58.1	2.2	21.9	21.7	
10.2	21.2	58.3	2.3	22.1	21.9	
10.6	21.8	58.7	2.6	22.2	22.0	
11.1	22	58.8	2.7	22.4	22.2	
11.5	22.4	58.8	3.0	22.5	22.3	
12	22.6	58.9	3.2	22.7	22.5	
12.4	22.8	58.8	3.4	22.8	22.6	
12.8	23	58.6	3.7	22.8	22.6	
13.7	23.4	58.1	4.8	23.0	22.8	

EXHIBIT 7

ASC H2O READSORPTION 57 %RH 6/25/86

TIME	LOAD	RH	BETA	b DATA	b TABLE 4	RATE CONSTANT b=.686511
0.0	0.0	7.2	0.0	0.0	0.0	CORRELATION COEFF R^2=0.984278
0.4	4.3	52.9	0.2	6.2	6.5	
0.7	7.9	54.9	0.4	9.9	10.3	
1.1	11.2	55.5	0.6	13.7	14.2	
1.4	13.7	55.9	0.8	16.0	16.5	
1.8	15.4	56.3	0.9	18.4	18.9	
2.2	17.7	56.6	1.2	20.2	20.6	
2.5	18.7	56.6	1.3	21.2	21.7	
2.9	20.5	56.7	1.6	22.4	22.7	
3.2	21.1	56.6	1.7	23.0	23.4	
3.6	22.1	56.5	1.9	23.7	24.0	
3.9	23.5	56.2	2.4	24.1	24.4	
4.6	24.5	56.4	2.9	24.8	25.0	
5.0	24.9	56.5	3.3	25.1	25.2	
5.4	25.2	56.5	3.6	25.3	25.4	
6.1	25.4	56.2	3.9	25.5	25.6	
6.4	25.6	56.0	4.5	25.6	25.7	
7.1	25.9	58.7		25.7	25.7	

EXHIBIT 8

ASC H2O ADSORPTION 80 %RH 3/2/86

TIME	LOAD	RH	BETA	b DATA	b TABLE 4	RATE CONSTANT b=0.177151
0.0	0.0	2.3	0.0	0.0	0.0	CORRELATION COEFF R^2=0.840982
0.5	3.2	71.1	0.1	3.2	3.2	
0.9	7.3	72.7	0.2	5.6	5.6	
1.3	11.0	74.0	0.3	7.8	7.8	
1.8	14.5	75.1	0.5	10.3	10.4	
2.2	17.6	76.3	0.6	12.2	12.3	
2.7	20.4	77.4	0.8	14.4	14.4	
3.1	22.9	78.3	0.9	16.0	16.1	
3.6	25.4	78.4	1.1	17.9	17.9	
4.0	27.6	79.1	1.3	19.2	19.3	
4.4	28.7	80.2	1.4	20.5	20.6	
4.9	30.5	81.1	1.6	22.0	22.0	
5.3	31.9	82.0	1.8	23.1	23.1	
5.8	32.8	82.7	2.0	24.3	24.4	
6.2	33.8	83.4	2.2	25.3	25.3	
6.6	34.2	84.0	2.3	26.1	26.2	
7.1	34.8	84.5	2.5	27.1	27.2	
7.5	35.4	85.0	2.7	27.9	27.9	
8.0	35.6	85.3	2.8	28.7	28.8	
8.9	36.0	86.0	3.0	30.1	30.1	
9.3	36.2	86.3	3.1	30.6	30.6	
9.7	36.5	86.6	3.3	31.1	31.1	
11.5	36.7	86.6	3.5	33.0	33.0	
12.8	36.9	86.3	3.6	34.0	34.0	
14.6	37.1	85.6	3.9	35.0	35.1	
23.9	37.3	84.6	4.1	37.4	37.4	
26.1	37.5	88.0	4.6	37.5	37.5	
29.2	37.7	93.5	5.2	37.7	37.7	
32.7	37.9	96.1		37.8	37.8	

EXHIBIT 9

ASC H2O READSORPTION AT 85 %RH 3/5/86

TIME	LOAD	RH	BETA	b DATA	b TABLE	4RATE CONSTANT b=0.434339
0	0	14.7	0.0	0.0	0.0	CORRELATION COEFF R^2=0.891054
0.4	0.1	22.9	0.0	6.3	7.0	
0.8	2.8	79.8	0.1	11.7	12.8	
1.2	6.4	80.1	0.2	16.1	17.6	
1.5	8.9	80.3	0.3	19.0	20.6	
1.9	11.7	80.5	0.3	22.3	24.0	
2.3	14.8	85.6	0.5	25.1	26.7	
2.7	17.3	81.2	0.6	27.4	29.0	
3.1	19.6	82.4	0.7	29.4	30.9	
3.4	21.9	85.3	0.8	30.6	32.1	
3.8	24	84.9	0.9	32.1	33.5	
4.2	26.2	84.7	1.1	33.3	34.6	
4.6	28	84.9	1.2	34.3	35.5	
5	29.8	84.9	1.4	35.2	36.2	
5.4	31.3	84.9	1.6	35.9	36.8	
5.7	32.9	85	1.8	36.4	37.2	
6.1	34.1	85	2.0	36.9	37.7	
6.5	35.4	84.9	2.2	37.3	38.0	
6.9	36.9	85.3	2.7	37.7	38.3	
7.3	37.7	85	3.0	38.0	38.6	
7.6	39	85	4.0	38.2	38.7	
8.6	39.7	85		38.8	39.1	

ASC H2O READSORPTION 78 %RH TABLE 4

b=0.6223
R^2=0.9959

TIME	LOAD	RH	BETA	DATA	
0.0	0.0	9.1	0.0	0.0	0.0
0.4	5.4	68.9	0.2	6.6	7.0
0.7	10.2	74.0	0.4	11.7	12.2
1.1	14.1	75.1	0.6	16.0	16.6
1.4	17.1	75.8	0.7	19.2	19.9
1.8	20.0	76.3	1.0	21.8	22.5
2.1	22.7	76.8	1.2	23.9	24.5
2.5	24.6	77.2	1.4	25.7	26.2
2.9	26.5	77.4	1.7	27.0	27.5
3.2	27.9	77.7	1.9	28.1	28.6
3.6	28.8	77.8	2.2	29.0	29.4
3.9	29.6	77.8	2.4	29.7	30.0
4.3	30.5	77.8	2.8	30.2	30.5
4.6	30.8	77.8	3.0	30.7	30.9
5.0	31.1	77.9	3.1	31.1	31.3
5.3	31.3	78.3	3.3	31.4	31.5
5.7	31.6	78.7	3.6	31.6	31.7
6.1	31.8	79.1	3.7	31.8	31.9
6.4	32.0	79.4	4.0	31.9	32.0
6.8	32.0	79.6	4.1	32.0	32.1
7.1	32.0	79.8	4.2	32.1	32.2
7.5	32.1	75.5	4.3	32.2	32.3
7.8	32.2	80.0	4.6	32.3	32.3
8.6	32.3	75.6	5.1	32.4	32.4
9.3	32.4	80.0	5.8	32.4	32.4
10.3	32.5	80.0	6.5	32.5	32.5
12.1	32.5	79.6		32.5	32.5

EXHIBIT 11

ASC H2O READSORPTION 80 %RH 6/30/86

TIME	LOAD	RH	b BETA	b DATA	TABLE 4	RATE CONSTANT b=0.760308
0.0	0.0	9.5	0.0	0.0	0.0	CORRELATION COEFF R^2=0.991105
0.4	7.0	66.8	0.3	7.9	6.6	
0.7	12.5	71.9	0.5	13.4	11.4	
1.1	16.9	73.6	0.8	17.6	15.3	
1.4	20.8	75.1	1.1	20.8	18.4	
1.8	23.3	76.0	1.4	23.3	21.0	
2.2	25.8	76.4	1.7	25.2	23.0	
2.5	27.3	76.9	2.1	26.6	24.6	
2.9	28.6	77.6	2.4	27.7	25.9	
3.2	28.9	78.3	2.6	28.6	27.0	
3.6	29.7	79.1	3.0	29.2	27.8	
3.9	29.9	75.8	3.1	29.7	28.5	
4.3	30.2	76.6	3.4	30.1	29.1	
4.6	30.3	77.3	3.5	30.4	29.5	
5.0	30.7	77.5	3.9	30.6	29.8	
5.7	30.8	78.4	4.1	30.9	30.4	
6.1	30.9	78.1	4.5	31.0	30.5	
7.9	31.3	79.4		31.2	31.0	

EXH[Belg 12

BASE CARBON H2O ADSORPTION 26 %RH

TIME	LOAD	RH	AVG RH=	26.5
0.0	0.0	7.5		
1.1	2.1	25.1		
1.5	2.3	26.4		
2.7	2.6	26.1		
6.5	2.3	26.8		
8	2.2	26.7		

INSUFFICIENT DATA TO ANALYZE FURTHER

P148563.PDF [Page: 61 of 96]

EXHIBIT 13

BASE CARBON H2O ADSORPTION 44 %RH 4/17/86

TIME	LOAD	RH	BETA	DATA
0.4	0.0	6.3	0.0	0.2
2.5	2.7	44.0	0.9	0.9
3.4	3.1	42.0	1.2	1.2
5.5	3.4	42.5	1.5	1.7
18.7	3.8	44.9	1.9	3.6
19.9	4.1	44.2	2.6	3.7
20.8	4.5	43.7		3.8
21.6	4.5	43.7		3.8

b=0.089
R^2=0.7805

EXHIBIT 14

BASE CARBON H2O ADSORPTION 59 %RH 4/18/86

TIME	LOAD	RH	BETA	b DATA	b TABLE 4
0.0	0.0	18.9	0.00	0.0	0
0.4	1.9	55.5	0.06	1.8	1.601724
0.9	3.3	57.1	0.10	3.5	3.072553
1.3	4.6	55.0	0.14	5.1	4.478486
1.7	5.6	55.2	0.18	6.6	5.822386
2.1	6.5	59.6	0.21	8.1	7.157179
2.5	8.6	60.1	0.28	9.4	8.382889
3.0	9.4	60.0	0.31	10.7	9.554519
3.4	10.9	60.1	0.37	11.9	10.67445
3.8	11.5	60.1	0.40	13.1	11.78680
4.2	12.8	60.1	0.45	14.2	12.80824
4.6	13.4	60.1	0.48	15.2	13.78461
5.5	14.9	59.9	0.55	17.2	15.64488
5.9	16.5	59.8	0.64	18.1	16.49609
6.3	17.2	59.7	0.68	19.0	17.34154
6.8	18.2	59.5	0.74	19.8	18.11790
7.2	18.6	59.4	0.76	20.6	18.88899
7.6	19.7	59.2	0.83	21.3	19.59707
8.5	20.3	59.0	0.87	22.7	20.94616
8.9	21.5	58.9	0.96	23.3	21.56347
9.3	22.4	58.8	1.02	23.9	22.17660
9.7	22.6	58.5	1.04	24.4	22.73963
10.2	23.2	58.2	1.09	25.0	23.29883
11.0	23.6	58.1	1.13	26.0	24.30319
11.4	23.8	61.5	1.15	26.4	24.79072
12.3	24.5	57.9	1.21	27.3	25.68305
12.7	25.5	58.0	1.31	27.7	26.09136
13.5	25.7	58.0	1.33	28.4	26.86931
14.0	26.8	58.0	1.45	28.7	27.23919
14.4	27.0	57.9	1.48	29.0	27.57884
14.8	27.2	57.9	1.51	29.4	27.91619
16.1	28.5	58.0	1.68	30.2	28.82723
16.5	28.7	57.9	1.72	30.4	29.09682
17.4	29.1	61.6	1.79	30.9	29.61045
17.8	29.3	61.7	1.82	31.1	29.85466
18.2	29.9	58.3	1.94	31.3	30.07891
18.7	30.3	58.2	2.03	31.5	30.30164
19.1	30.8	58.3	2.12	31.6	30.51416
20.4	31.4	58.3	2.28	32.1	31.08114
20.8	31.6	58.4	2.35	32.3	31.25792
21.6	32.0	61.3	2.48	32.5	31.58150
22.5	32.2	58.1	2.55	32.8	31.88214
24.2	32.6	61.5	2.72	33.2	32.40045
24.6	32.8	61.5	2.82	33.3	32.51237
25.5	33.1	61.4	2.92	33.4	32.72961
28.5	33.5	60.9	3.17	33.9	33.34200
29.8	33.9	60.3	3.51	34.1	33.54899
31.1	34.3	59.7	4.02	34.2	33.73130
32.8	34.3	58.9	4.02	34.3	33.93589
33.2	34.7	58.7	5.12	34.4	33.98180
33.7	34.9	58.5			34.02560
35.4	34.3	59.2			33.56759

RATE CONSTANT b=0.123760
CORRELATION COEFF R^2=0.968

P148563.PDF [Page 103 of 961]

EXHIBIT 15

BASE CARBON ADS 60 %RH 6/16/86

TIME	LOAD	RH	BETA	DATA	TABLE 4
0.0	0.0	29.8	0.0	0.3	0.0
0.4	4.2	55.7	0.1	5.7	3.2
0.7	7.3	57.2	0.3	10.1	5.8
1.1	9.8	57.5	0.4	13.7	8.2
1.4	12.4	57.7	0.5	16.8	10.4
1.8	14.2	58.1	0.6	19.4	12.5
2.2	16.0	58.8	0.7	21.5	14.3
2.5	17.6	56.1	0.8	23.3	15.9
2.9	19.3	56.5	0.9	24.9	17.5
3.2	20.6	56.8	1.0	26.1	18.8
3.6	22.1	57.1	1.1	27.1	20.0
3.9	23.5	57.1	1.3	28.0	21.1
4.3	24.3	57.1	1.4	28.7	22.2
4.6	25.5	60.4	1.5	29.3	23.1
5.0	26.8	57.3	1.7	29.8	24.0
5.4	27.4	57.9	1.9	30.3	24.8
5.7	28.0	58.6	2.0	30.6	25.4
6.1	28.5	59.2	2.1	30.9	26.1
6.4	29.2	57.0	2.3	31.2	26.7
6.8	30.2	57.7	2.7	31.4	27.2
7.1	30.9	58.4	3.0	31.6	27.7
7.5	31.4	58.8	3.4	31.7	28.1
7.8	31.8	59.1	4.0	31.8	28.5
8.2	32.0	59.4	4.4	31.9	28.9
8.6	32.3	59.3	5.2	32.0	29.2
12.5	32.4	59.8		32.4	31.3
12.9	32.4	59.6		32.4	31.4

b=0.507
R^2=0.903

EXHIBIT 16

BASE CARBON H2O ADSORPTION AT 60 %RH

TIME	LOAD	RH	BETA	b DATA	b TABLE	4RATE CONSTANT b=0.093095
0.0	0.0	36.4	0.0	0.0	0.0	CORRELATION COEFF R^2=0.965193
0.4	1.2	57.3	0.0	1.2	1.3	
0.7	2.5	59.3	0.1	2.2	2.5	
1.1	4.7	60.0	0.2	3.2	3.7	
1.5	6.3	60.4	0.2	4.2	4.8	
1.8	8.5	60.6	0.3	5.1	5.9	
2.2	9.8	60.5	0.3	6.0	6.9	
2.5	11.7	60.6	0.4	6.9	7.9	
2.9	12.8	60.8	0.5	7.8	8.8	
3.2	14.1	60.8	0.6	8.6	9.7	
3.6	15.2	60.8	0.6	9.4	10.6	
3.9	16.3	60.9	0.7	10.2	11.5	
4.3	17.1	61.0	0.7	10.9	12.3	
4.6	17.8	60.2	0.8	11.6	13.1	
5.0	18.5	60.3	0.8	12.3	13.8	
5.4	18.9	60.3	0.8	13.0	14.6	
5.7	19.7	60.3	0.9	13.6	15.2	
6.1	20.1	60.6	0.9	14.3	15.9	
6.4	20.6	60.8	1.0	14.9	16.6	
6.8	21.0	61.0	1.0	15.5	17.2	
7.1	21.3	61.2	1.0	16.1	17.8	
7.5	22.1	61.3	1.1	16.6	18.4	
7.8	22.5	61.2	1.1	17.1	18.9	
8.2	22.9	61.3	1.2	17.7	19.5	
8.6	23.3	61.2	1.2	18.2	20.0	
8.9	23.8	61.4	1.3	18.7	20.5	
9.3	24.0	61.5	1.3	19.1	21.0	
9.6	24.4	61.7	1.3	19.6	21.4	
10.0	24.6	62.2	1.4	20.0	21.9	
10.3	24.8	59.3	1.4	20.5	22.3	
10.7	25.1	59.6	1.4	20.9	22.7	
11.1	25.6	59.9	1.5	21.3	23.1	
11.4	26.1	60.1	1.6	21.7	23.5	
11.8	26.4	60.3	1.6	22.0	23.9	
12.1	26.8	60.3	1.7	22.4	24.2	
12.5	27.2	60.5	1.7	22.8	24.5	
12.9	27.3	60.7	1.7	23.1	24.9	
13.2	27.5	60.8	1.8	23.4	25.2	
13.6	27.8	61.1	1.8	23.7	25.5	
14.3	27.9	61.3	1.9	24.3	26.1	
15.0	28.3	61.2	1.9	24.9	26.6	
16.4	28.6	60.7	2.0	25.9	27.5	
16.8	28.7	60.6	2.0	26.2	27.7	
17.2	28.8	60.4	2.0	26.4	27.9	
17.5	28.9	60.5	2.1	26.6	28.1	
19.3	29.1	59.7	2.1	27.6	29.0	
20.0	29.2	63.0	2.1	28.0	29.3	
21.8	29.3	59.5	2.2	28.8	30.0	
22.6	29.5	59.8	2.2	29.1	30.2	
22.9	29.6	60.1	2.2	29.2	30.3	
23.7	29.8	60.4	2.3	29.4	30.6	
24.4	30.0	61.0	2.4	29.7	30.7	
25.8	30.2	62.4	2.4	30.1	31.1	
26.2	30.7	59.2	2.6	30.2	31.2	
26.6	30.8	59.6	2.7	30.3	31.2	
26.9	30.9	59.8	2.7	30.4	31.3	
27.3	31.1	60.1	2.8	30.5	31.4	
27.6	31.3	60.4	2.9	30.6	31.4	
28.4	31.4	60.8	3.0	30.7	31.6	
28.7	31.5	61.1	3.0	30.8	31.6	
29.8	31.7	61.6	3.2	31.0	31.8	
30.2	31.8	61.6	3.3	31.1	31.8	
30.9	31.9	61.9	3.3	31.2	31.9	
31.6	32.0	62.1	3.4	31.4	32.0	
32.4	32.1	62.3	3.5	31.5	32.1	
33.1	32.2	62.3	3.6	31.6	32.2	
33.8	32.3	62.2	3.7	31.7	32.3	
47.8	32.5	59.4	4.0	32.7	32.9	
50.0	32.7	61.1	4.3	32.8	33.0	
51.9	33.0	58.9	5.9	32.8	33.0	
52.6	33.1	59.3		32.9	33.0	

BASE CARBON ADS 62 %RH

TIME	LOAD	RH	BETA	DATA	TABLE 4b=0.344248-
0.0	0.0	6.5	0.0	0.2	0.0 R^2=0.8132
0.4	2.0	52.2	0.1	3.8	3.0
0.7	4.9	59.4	0.2	7.1	5.5
1.1	6.3	60.2	0.2	10.0	8.0
1.4	8.2	60.6	0.3	12.6	10.1
1.8	9.4	61.1	0.3	14.8	12.1
2.1	11.1	61.4	0.4	16.8	13.9
2.5	12.1	61.7	0.5	18.6	15.6
2.9	13.6	61.9	0.5	20.2	17.0
3.2	14.9	62.1	0.6	21.5	18.4
3.6	15.6	62.2	0.7	22.8	19.7
3.9	16.9	62.1	0.7	23.9	20.8
4.3	17.6	61.9	0.8	24.8	21.8
4.6	18.4	62.2	0.8	25.7	22.7
5.0	19.7	62.5	0.9	26.5	23.6
5.3	20.3	59.4	1.0	27.1	24.4
5.7	21.5	60.0	1.1	27.7	25.1
6.1	22.3	60.3	1.2	28.2	25.7
6.4	23.2	60.5	1.3	28.7	26.3
6.8	23.5	60.6	1.3	29.1	26.9
7.1	24.6	60.7	1.4	29.5	27.3
7.5	25.2	60.8	1.5	29.8	27.8
7.8	25.8	64.4	1.6	30.1	28.2
8.2	26.6	64.5	1.7	30.3	28.5
8.6	26.8	61.0	1.8	30.6	28.9
8.9	27.4	61.1	1.9	30.8	29.2
9.3	28.2	64.9	2.1	30.9	29.5
9.6	28.5	61.3	2.1	31.1	29.7
10.0	29.1	61.3	2.3	31.2	30.0
10.3	29.6	61.4	2.5	31.3	30.2
10.7	29.8	61.4	2.6	31.4	30.4
11.1	30.5	61.5	2.9	31.5	30.5
11.4	30.7	65.1	3.0	31.6	30.7
12.1	31.2	65.1	3.5	31.8	31.0
12.8	31.5	65.0	3.7	31.9	31.2
13.2	31.7	64.9	4.1	31.9	31.3
13.6	32.1	64.5	5.5	32.0	31.4
14.3	32.2	63.1	7.4	32.0	31.5
16.4	32.3	60.8		32.1	31.9

P148563.PDF [Page 60 of 136]

EXHIBIT 18

BASE CARBON H2O ADSORPTION AT 60 %RH 6/1/86

TIME	LOAD	RH	BETA	PRELOAD	TABLE 4	
0.0	0.5	47.4	0.0	0.0	0.0	b=0.331
0.4	2.3	52.2	0.1	3.7	3.0	R^2=.900
0.7	4.0	55.2	0.1	6.7	5.5	
1.1	5.7	59.1	0.2	9.3	7.8	
1.4	7.3	58.8	0.3	11.7	9.9	
1.8	8.7	58.3	0.3	13.8	11.7	
2.2	9.9	58.1	0.4	15.8	13.5	
2.5	11.4	59.2	0.5	17.4	15.1	
2.9	12.5	59.4	0.5	18.9	16.5	
3.2	13.7	59.1	0.6	20.3	17.9	
3.6	14.8	59.2	0.7	21.5	19.0	0.2669
3.9	15.7	59.2	0.7	22.5	20.1	
4.3	16.6	58.9	0.8	23.5	21.1	
4.6	17.5	58.5	0.8	24.3	22.0	
5.0	18.4	58.2	0.9	25.0	22.8	
5.4	19.3	58.4	1.0	25.7	23.6	
5.7	20.0	58.5	1.0	26.3	24.2	
6.1	20.7	58.5	1.1	26.8	24.8	
6.4	21.4	58.4	1.2	27.3	25.4	
6.8	22.2	58.1	1.3	27.7	25.9	
7.1	22.8	58.0	1.3	28.0	26.4	
7.5	23.4	57.9	1.4	28.4	26.8	
7.8	23.9	58.0	1.5	28.6	27.2	
8.2	24.6	58.2	1.6	28.9	27.5	
8.6	25.1	58.7	1.7	29.1	27.8	
8.9	25.5	59.2	1.7	29.3	28.1	
9.3	26.2	59.4	1.9	29.5	28.4	
9.6	26.6	59.8	2.0	29.7	28.6	
10.0	27.0	59.9	2.1	29.8	28.8	
10.3	27.6	59.7	2.2	30.0	29.0	
10.7	27.9	59.5	2.3	30.1	29.2	
11.1	28.2	59.4	2.4	30.2	29.4	
11.4	28.6	59.3	2.6	30.3	29.5	
11.8	28.8	59.1	2.7	30.3	29.7	
12.1	29.2	62.2	2.9	30.4	29.8	
12.5	29.5	61.8	3.1	30.5	29.9	
12.9	29.8	61.6	3.2	30.5	30.0	
13.2	29.9	61.3	3.4	30.6	30.1	
13.6	30.1	61.2	3.6	30.6	30.2	
13.9	30.3	61.0	3.8	30.7	30.2	
14.3	30.4	60.9	4.0	30.7	30.3	
14.6	30.5	60.8	4.3	30.7	30.4	
15.0	30.6	60.4	4.5	30.7	30.4	
15.4	30.7	60.2	4.9	30.8	30.5	
15.7	30.8	59.9	5.2	30.8	30.5	
16.1	30.8	59.7	5.5	30.8	30.6	
16.4	30.9	59.6	5.8	30.8	30.6	
17.5	30.9	63.2	7.4	30.9	30.7	
17.9	31.0	63.1		30.9	30.7	

EXHIBIT 19

BASE CARBON H2O ADSORPTION 85 %RH

TIME	LOAD	RH	BETA	b DATA	b TABLE	4RATE CONSTANT b=0.276468
0	0	14.7	0	0.0	0	CORRELATION COEFF R^2=0.98541
0.4	0.1	22.9	0.00	4.9	4.1923	
0.8	2.8	79.8	0.06	9.3	8.0099	
1.2	6.4	80.1	0.14	13.2	11.486	
1.5	8.9	80.3	0.21	15.9	13.888	
1.9	11.7	80.5	0.28	19.2	16.839	
2.3	14.8	85.6	0.37	22.1	19.526	
2.7	17.3	81.2	0.46	24.7	21.973	
3.1	19.6	82.4	0.54	27.0	24.201	
3.4	21.9	85.3	0.62	28.6	25.740	
3.8	24	84.9	0.71	30.5	27.632	
4.2	26.2	84.7	0.81	32.2	29.354	
4.6	28	84.9	0.90	33.8	30.922	
5	29.8	84.9	1.00	35.1	32.351	
5.4	31.3	84.9	1.10	36.4	33.651	
5.7	32.9	85	1.20	37.2	34.550	
6.1	34.1	85	1.29	38.2	35.654	
6.5	35.4	84.9	1.40	39.1	36.659	
6.9	36.9	85.3	1.54	39.9	37.574	
7.3	37.7	85	1.62	40.7	38.408	
7.6	39	85	1.78	41.2	38.984	
8	39.7	90.2	1.87	41.8	39.691	
8.4	40.5	85	1.99	42.3	40.336	
8.8	41.3	85.1	2.12	42.8	40.922	
9.2	41.8	90.3	2.21	43.2	41.457	
9.5	42.3	90.3	2.32	43.5	41.826	
9.9	42.5	90.3	2.36	43.9	42.279	
10.3	43	90.3	2.48	44.2	42.692	
10.7	43.6	90.3	2.65	44.5	43.068	
11.1	43.8	90	2.71	44.7	43.411	
11.5	44.1	90.3	2.81	44.9	43.723	
11.8	44.3	90.3	2.89	45.1	43.938	
12.2	44.6	90.3	3.01	45.3	44.203	
13.4	44.8	91	3.10	45.7	44.863	
13.7	45.1	90.9	3.26	45.8	45.001	
14.1	45.6	85.5	3.58	45.9	45.171	
14.9	45.8	85.4	3.75	46.1	45.466	
15.3	46.1	85.4	4.07	46.2	45.594	
16.4	46.4	85.3	4.54	46.4	45.891	
16.8	46.6	85.2	5.05	46.4	45.981	
17.9	46.9	85.2		46.6	46.189	
19.8	46.9	84.9		46.7	46.444	

EXHIBIT 29

BASE CARBON H2O ADSORPTION 83 %RH

TIME	LOAD	RH	BETA	b DATA	b TABLE 4	RATE CONSTANT b=0.222734
0.0	0.0	8.8	0	0.0	0.0	CORRELATION COEFF R^2=0.967484
0.4	3.3	82.5	0.06	4.5	4.8	
0.9	6.6	79.8	0.14	8.4	8.9	
1.3	9.7	80.5	0.22	12.0	12.7	
1.7	12.7	80.8	0.30	15.2	16.1	
2.1	15.8	80.9	0.39	18.3	19.3	
2.5	18.1	81.0	0.46	21.0	22.1	
3.0	21.2	81.1	0.56	23.5	24.6	
3.4	23.7	81.2	0.66	25.8	27.0	
3.8	26.0	82.4	0.76	27.8	29.0	
4.2	28.6	83.3	0.88	29.7	30.9	
4.7	30.1	84.2	0.96	31.5	32.6	
5.1	31.9	85.1	1.06	33.0	34.2	
5.5	34.7	85.9	1.24	34.4	35.5	
5.9	36.7	85.7	1.40	35.7	36.8	
6.3	38.3	84.6	1.53	36.9	38.0	
6.8	38.8	84.2	1.58	38.0	39.0	
7.2	40.3	83.7	1.75	38.9	39.9	
7.6	41.3	83.2	1.88	39.8	40.8	
8.0	42.1	82.8	1.99	40.6	41.5	
8.5	43.4	87.3	2.20	41.3	42.2	
8.9	43.9	86.8	2.30	42.0	42.9	
9.3	44.2	86.4	2.36	42.6	43.4	
9.7	44.7	86.0	2.47	43.2	43.9	
10.2	44.7	85.8	2.47	43.7	44.4	
10.6	45.4	85.6	2.68	44.1	44.8	
11.0	45.2	85.6	2.61	44.6	45.2	
11.4	45.9	85.5	2.85	44.9	45.5	
11.9	45.9	85.5	2.85	45.3	45.9	
12.3	46.2	85.6	2.94	45.6	46.1	
12.7	46.2	84.9	2.94	45.9	46.4	
13.1	46.2	84.2	2.94	46.1	46.6	
13.6	45.9	83.5	2.85	46.4	46.8	
14.0	46.5	82.8	3.05	46.6	47.0	
14.4	46.7	82.6	3.17	46.8	47.2	
14.8	46.5	83.3	3.05	47.0	47.3	
15.3	46.2	84.9	2.94	47.1	47.5	
15.7	46.5	81.9	3.05	47.3	47.6	
16.1	47.0	83.7	3.30	47.4	47.7	
16.5	47.0	85.5	3.30	47.5	47.8	
17.0	47.7	87.0	3.86	47.6	47.9	
17.4	47.5	88.6	3.64	47.7	48.0	
17.8	47.7	89.9	3.86	47.8	48.1	
18.2	47.7	89.2	3.86	47.9	48.1	
18.7	48.2	88.7	4.55	48.0	48.2	
19.1	47.7	88.6	3.86	48.1	48.2	
19.5	48.2	88.7	4.55	48.1	48.3	
19.9	48.5	87.9	5.25	48.2	48.3	
20.4	48.8	87.2		48.2	48.4	
20.8	48.8	86.6			48.4	
21.2	48.5	85.4			48.2	
21.7	48.2	85.1			48.0	
22.1	47.5	85.0			47.5	
22.5	47.7	85.0			47.5	
22.9	47.5	85.0			47.5	
23.4	47.7	84.8			47.6	

EXHIBIT 21
BASE CARBON H2O ADSORPTION 97 %RH 5/16/86

TIME	LOAD	RH	BETA	b DATA	b TABLE	4RATE CONSTANT b=0.118447
0	0	37.4	0.00	0.0	0.0	CORRELATION COEFF R^2=0.835828
0.4	3.1	86.6	0.06	2.3	2.3	
0.7	5.89	88.4	0.12	4.0	4.0	
1.1	8.56	88.7	0.19	6.2	6.2	
1.4	11.1	88.6	0.25	7.7	7.7	
1.8	13.4	88.4	0.31	9.7	9.7	
2.1	15.7	88.1	0.37	11.1	11.1	
2.5	17.8	93	0.44	12.9	13.0	
2.8	19.9	92.6	0.50	14.2	14.3	
3.1	21.8	92.4	0.57	15.5	15.5	
3.5	23.8	92.2	0.64	17.1	17.2	
3.8	25.5	91.9	0.71	18.3	18.3	
4.2	27.2	91.5	0.77	19.8	19.8	
4.5	28.8	91.3	0.85	20.9	20.9	
4.9	30.3	91	0.92	22.2	22.3	
5.2	31.8	90.8	1.00	23.2	23.2	
5.6	33.2	90.5	1.08	24.5	24.5	
5.9	34.4	90.3	1.15	25.4	25.4	
6.3	35.7	89.9	1.23	26.5	26.6	
6.6	36.8	89.7	1.31	27.4	27.4	
7	37.7	89.3	1.38	28.4	28.5	
7.3	38.8	94.2	1.47	29.2	29.3	
7.7	39.7	88.7	1.55	30.2	30.2	
8	40.4	93.6	1.61	30.9	30.9	
8.4	41.1	88.1	1.69	31.8	31.9	
8.7	41.7	93.4	1.75	32.5	32.5	
9.1	42.2	93.1	1.82	33.3	33.3	
9.4	42.8	93.2	1.88	33.9	33.9	
10.1	43.4	93.2	1.97	35.2	35.3	
10.5	43.8	93.3	2.03	35.9	36.0	
10.8	44.2	93.3	2.09	36.4	36.5	
11.2	44.4	93.5	2.13	37.1	37.1	
11.5	44.7	88.5	2.17	37.6	37.6	
11.9	45	94.5	2.22	38.1	38.2	
12.2	45.3	102.	2.29	38.6	38.6	
12.6	45.6	103.	2.35	39.1	39.2	
12.9	45.8	98.5	2.39	39.5	39.6	
13.3	45.9	98.9	2.40	40.0	40.1	
13.6	46	99.3	2.42	40.4	40.4	
14	46.0	99.4	2.44	40.9	40.9	
14.7	46.3	100.	2.49	41.6	41.7	
15.4	46.4	101.	2.54	42.3	42.4	
16.1	46.7	102.	2.60	43.0	43.0	
16.4	46.8	102.	2.64	43.2	43.3	
17.5	47.0	99.5	2.68	44.1	44.2	
18.6	47.1	94.8	2.71	44.9	44.9	
18.9	47.2	100.	2.73	45.1	45.1	
20.3	47.3	100	2.76	45.9	45.9	
21.7	47.4	99.3	2.81	46.6	46.6	
22.1	47.5	104.	2.84	46.8	46.8	
23.2	47.5	107.	2.86	47.2	47.3	
23.5	47.6	107.	2.90	47.4	47.4	
24.6	47.8	107	2.94	47.7	47.8	
26.7	47.8	105.	2.96	48.3	48.4	
27.1	48	105.	3.01	48.4	48.5	
28.8	48.1	104.	3.08	48.8	48.8	
31.3	48.2	98	3.10	49.2	49.3	
34.5	48.7	103.	3.34	49.6	49.6	
34.9	48.9	103.	3.51	49.7	49.7	
35.3	49.0	103.	3.59	49.7	49.7	
35.6	49.3	104.	3.84	49.7	49.7	
36	49.7	104.	4.17	49.8	49.8	
36.3	49.8	104.	4.42	49.8	49.8	
36.7	50.3	104.	5.69	49.8	49.8	
37.4	50.4	105.	6.58	49.9	49.9	
38.5	50.4	106.	7.83	50.0	50.0	
39.2	50.4	107.		50.0	50.0	

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EXHIBIT 22

ASC H2O DESORPTION FROM 20 %RH 6/20/86

TIME	LOAD	LOSS	RH	BETA	PRELOAD	b=1.83551
0.0	3.0	0.0	10.3	0	2.8	R^2=0.830
0.7	0.7	2.3	6.8	1.9	1.0	
1.1	0.7	2.3	7.2	1.8	0.6	
1.5	0.3	2.7	7.2		0.4	

P148563.PDF [Page: 72 of 96]

EXHIBIT 23

ASC H2O DESORPTION FROM 45 %RH 6/18/86

TIME	LOAD	LOSS	RH	BETA	PRELOAD	
0.0	16.5	0.0	46.4	0.0	16.0	b=1.634862
0.4	11.5	5.0	7.4	0.4	8.8	R^2=0.993589
0.7	7.2	9.3	6.9	0.8	5.0	
1.1	4.1	12.4	7.1	1.4	2.8	
1.4	1.9	14.6	6.8	2.2	1.6	
1.8	1.0	15.5	6.8	2.8	0.9	
2.2	0.6	15.9	7.0	3.3	0.5	
2.5	0.3	16.2	6.6	4.0	0.3	
2.9	0.2	16.3	6.6	4.4	0.2	
3.2	0.0	16.5	6.7		0.1	

P148563.PDF [Page: 73 of 96]

EXHIBIT 24

ASC H2O DESORPTION FROM 65 %RH 6/27/86

TIME	LOAD	LOSS	RH	BETA	PRELOAD
0.0	31.5	0.0	65.2	0.0	31.5
0.4	24.8	6.7	7.4	0.2	21.8
0.7	18.9	12.6	6.4	0.5	16.7
1.1	14.3	17.2	7.1	0.8	11.7
1.4	10.5	21.0	7.0	1.2	9.1
1.8	7.3	24.2	6.8	1.6	6.5
2.2	5.3	26.2	7.1	2.0	4.8
2.5	3.3	28.2	6.8	2.6	3.9
2.9	2.5	29.0	6.8	3.1	3.0
3.2	1.9	29.6	5.9	3.6	2.5
3.6	1.7	29.8	6.5	3.9	2.1
4.3	1.5	30.0	6.3	4.3	1.6
4.6	1.4	30.1	6.6	4.6	1.5
5.7	1.3	30.2	6.2	5.0	1.2
6.4	1.2	30.3	6.4	5.7	1.2
7.1	1.1	30.4	5.9		1.1

b=0.9571
R^2=0.9735

EXHIBIT 25

ASC H2O DESORPTION FROM 80 %RH 6/30/86

TIME	LOAD	LOSS	RH	BETA	PRELOAD	TABLE 5	
0.0	32.5	0.0	79.7	0.0	32.2	32.2	b=0.2656
0.4	24.8	7.7	7.0	0.3	29.4	29.5	R^2=0.8638
0.7	17.4	15.1	6.1	0.6	26.8	27.0	
1.1	11.9	20.6	6.5	1.0	24.4	24.8	
1.5	7.9	24.6	5.8	1.4	22.2	22.6	
1.8	5.0	27.4	5.9	1.9	20.2	20.7	
2.2	3.5	29.0	6.0	2.3	18.4	19.0	
2.5	2.7	29.7	5.3	2.6	16.8	17.4	
2.9	2.5	29.9	5.4	2.6	15.3	15.8	
3.2	2.4	30.0	5.7	2.7	14.0	14.5	
3.9	2.4	30.1	5.9	2.7	11.6	12.2	
4.3	2.2	30.3	5.9	2.8	10.6	11.1	
4.6	2.1	30.4	5.7	2.8	9.7	10.2	
5.0	2.1	30.4	5.9	2.9	8.8	9.3	
5.4	2.0	30.5	5.9	2.9	8.0	8.6	
5.7	1.9	30.6	5.9	3.0	7.3	7.8	
6.4	1.7	30.7	6.0	3.1	6.1	6.6	
6.8	1.5	30.9	6.3	3.2	5.6	6.0	
7.1	1.5	31.0	5.5	3.3	5.1	5.6	
8.2	1.2	31.2	5.8	3.5	3.9	4.3	
8.9	1.2	31.3	6.0	3.5	3.3	3.6	
9.3	1.1	31.4	5.6	3.6	3.0	3.3	
10.4	1.1	31.4	5.6	3.7	2.3	2.6	
11.4	0.9	31.6	5.8	3.9	1.8	2.1	
11.8	0.8	31.7	6.5	4.1	1.6	1.9	
12.9	0.7	31.8	5.9	4.2	1.3	1.5	
13.2	0.6	31.8	6.0	4.4	1.2	1.4	
13.9	0.6	31.9	5.4	4.6	1.0	1.2	
14.7	0.5	32.0	5.7	4.9	0.9	1.1	
15.0	0.3	32.1	6.3	5.8	0.8	1.0	
15.7	0.2	32.2	6.5		0.7	0.9	

EXHIBIT 26

BASE CARBON DES FROM 60 %RH 4/21/86

b=0.2536
R^2=0.8753

TIME	LOAD	LOSS	RH	BETA	PRELOADTABLE 6	6
0.0	36.6	0.0	59.0	0.0	36.6	36.6
0.4	32.6	4.0	8.3	0.1	32.9	32.5
0.8	28.6	8.0	7.6	0.2	29.6	28.9
1.3	24.4	12.2	8.1	0.4	26.5	25.6
1.7	20.5	16.1	7.7	0.6	23.9	22.7
2.1	18.0	18.6	7.5	0.7	21.5	20.2
2.5	13.6	23.0	7.5	1.0	19.3	17.8
3.0	11.0	25.6	7.5	1.2	17.3	15.9
3.4	8.5	28.1	7.2	1.5	15.6	14.1
3.8	6.6	30.0	6.8	1.7	14.0	12.5
4.2	4.9	31.7	6.8	2.0	12.6	11.1
4.6	3.4	33.2	6.8	2.4	11.3	9.8
5.1	2.3	34.3	7.1	2.8	10.2	8.7
5.5	2.5	34.1	7.2	2.7	9.1	7.7
5.9	2.3	34.3	7.2	2.8	8.2	6.9
7.2	2.1	34.5	7.4	2.8	5.9	4.8
8.9	1.9	34.7	7.2	3.0	3.9	3.0
9.7	1.7	34.9	7.0	3.1	3.1	2.3
10.1	1.5	35.1	7.3	3.2	2.8	2.1
11.4	1.3	35.3	7.3	3.4	2.0	1.4
16.1	1.1	35.5	7.4	3.5	0.6	0.4
16.9	0.4	36.2	7.3	4.5	0.5	0.3
17.4	0.2	36.4	7.6	5.2	0.4	0.3
21.6	0.0	36.6	7.3		0.2	0.1

EXHIBIT 27

BASE CARBON H2O DESORPTION FROM 60 %RH 6/15/86

b=0.3127
R^2=0.8879

TIME	LOAD	LOSS	RH	BETA	PRELOAD
0.0	33.3	0.0	35.7	0.0	33.1
0.4	24.8	8.5	4.8	0.3	29.7
0.7	17.8	15.5	4.8	0.6	26.7
1.1	12.7	20.6	4.9	1.0	23.9
1.4	8.5	24.8	4.6	1.4	21.4
1.8	5.2	28.1	5.1	1.9	19.2
2.1	3.8	29.5	4.5	2.2	17.2
2.5	3.3	30.0	4.7	2.4	15.4
3.6	3.2	30.1	4.8	2.4	11.1
3.9	3.0	30.3	5.0	2.5	9.9
5.0	2.9	30.4	4.4	2.5	7.2
5.3	2.8	30.5	4.7	2.5	6.5
6.1	2.7	30.6	5.6	2.6	5.2
6.8	2.6	30.7	5.1	2.6	4.2
7.5	2.3	31.0	5.7	2.8	3.4
7.8	1.9	31.4	5.9	3.0	3.1
8.2	1.8	31.5	5.8	3.1	2.8
8.5	1.6	31.7	6.6	3.2	2.5
8.9	1.3	32.0	5.6	3.4	2.3
9.3	1.3	32.0	6.1	3.4	2.1
9.6	1.1	32.2	6.8	3.6	1.9
10.0	1.0	32.3	7.0	3.7	1.7
10.3	0.9	32.4	6.1	3.9	1.5
10.7	0.8	32.5	6.7	4.1	1.4
11.4	0.5	32.8	6.6	4.7	1.2
11.8	0.4	32.9	6.3	5.2	1.1
12.1	0.2	33.1	7.1		1.0

P148563.PDF [Page 37 of 96]

EXHIBIT 28

DESORPTION FROM 62 %RH

TIME	LOAD	LOSS	RH	BETA	PRELOAD
0.0	37.1	0.0	61.9	0.0	36.9
0.7	27.4	9.7	4.9	0.3	28.9
1.1	23.0	14.1	5.1	0.5	25.7
1.4	19.0	18.1	5.2	0.7	22.8
1.8	15.4	21.7	5.0	0.9	20.2
2.2	12.1	25.0	4.8	1.1	17.9
2.5	9.1	28.0	5.8	1.4	15.9
2.9	6.6	30.5	5.9	1.7	14.1
3.2	4.6	32.5	4.9	2.1	12.5
3.6	2.8	34.3	4.8	2.6	11.1
3.9	1.6	35.5	5.0	3.2	9.8
4.3	1.1	36.0	4.9	3.5	8.7
5.7	0.8	36.3	5.0	3.9	5.4
8.9	0.7	36.4	5.4	4.0	1.8
9.6	0.6	36.5	5.5	4.1	1.4
10.7	0.6	36.5	5.2	4.2	1.0
11.8	0.5	36.6	5.4	4.3	0.7
12.5	0.5	36.6	5.9	4.4	0.6
12.9	0.3	36.8	5.8	4.8	0.5
14.6	0.1	37.0	6.2	5.9	0.3
15.4	0.1	37.0	6.5		0.2
15.7	0.0	37.1	5.7		0.2

b=0.3391

R^2=0.8608

EXHIBIT 29

DES FROM 85 %RH 4/28/86

TIME	LOAD	LOSS	RH	BETA	PRELOAD
0	48	0	85	*****	48.0
0.4	46.2	1,8	21.6	*****	35.5
0.9	40.3	7.7	8.2	*****	24.3
1.3	35	13	7.5	*****	18.0
1.7	29.8	18.2	9.1	*****	13.3
2.1	25.5	22.5	8.4	*****	9.9
2.5	21.1	26.9	9.6	*****	7.3
3	17.2	30.8	9	*****	5.0
3.4	13.2	34.8	8.2	*****	3.8
3.8	10.1	37.9	7.9	*****	2.8
4.2	7.3	40.7	8.1	*****	2.1
4.7	4.5	43.5	8.7	*****	1.5
5.1	2.4	45.6	8.9	*****	1.1
5.5	1.4	46.6	9	*****	0.8
5.9	1.1	46.9	7.7	*****	0.6
6.3	1	47	7.9	*****	0.5
6.8	0.7	47.3	8	*****	0.4
7.2	0.4	47.6	8	*****	0.3
13.6	0.1	47.9	8.1		0.1
16.5	0.1	47.9	8.4		0.1

b=0.7571
R^2=0.9591

P148563.PDF [Page 79 of 406]

EXHIBIT 30

BASE CARBON H2O DESORPTION FROM 85 TO 65 %RH

b=0.1127
R^2=0.8189

TIME	LOAD	LOSS	RH	BETA	PRELOAD
0	46.9	0.0	74.4	0	46.9
0.4	46.4	0.5	74.1	0.1	46.7
0.8	45.8	1.1	72.4	0.3	46.6
1.1	45.1	1.8	65.8	0.6	46.4
1.5	44.3	2.6	65.8	1.1	46.3
2.3	44.1	2.8	66.5	1.3	46.0
11.4	43.8	3.1	64.6	1.6	44.1
15.3	43.6	3.3	66.9	1.9	43.7
16.8	43.3	3.6	65.7	2.6	43.6
17.5	43	3.9	67.1		43.5

EXHIBIT 31

BASE CARBON H2O DESORPTION FROM 65 TO 42 %RH 3/5/86

b=0.0808

R^2=0.9603

TIME	LOAD	LOSS	RH	BETA	PRELOAD
0	42.8	0.0	66	0	42.8
1.9	42.3	0.5	56.4	0.0	38.9
2.3	42	0.8	58.3	0.0	38.1
2.7	41.8	1.0	58	0.0	37.4
3.1	41.5	1.3	54.6	0.0	36.7
3.8	40.8	2.0	54.3	0.1	35.5
4.2	40.2	2.6	46.4	0.1	34.9
4.6	39.5	3.3	46.1	0.1	34.3
5	38.7	4.1	45.9	0.2	33.7
5.4	38	4.8	43.4	0.2	33.1
5.7	37.4	5.4	42.4	0.2	32.6
6.1	36.4	6.4	42.4	0.3	32.1
6.5	36.2	6.6	42.4	0.3	31.6
6.9	35.7	7.1	42.2	0.3	31.0
7.3	34.9	7.9	42.0	0.3	30.5
7.6	34.6	8.2	41.9	0.4	30.2
8	33.9	8.9	41.9	0.4	29.7
8.8	33.4	9.4	41.5	0.4	28.8
9.5	32.6	10.2	42.4	0.5	28.1
9.9	31.8	11.0	42.8	0.5	27.7
10.7	31.3	11.5	42.6	0.5	26.9
11.1	31.1	11.7	42.4	0.6	26.5
11.5	30.6	12.2	42.3	0.6	26.2
11.8	30.3	12.5	41.7	0.6	25.9
12.2	30.1	12.7	41.5	0.6	25.6
12.6	29.6	13.2	41.3	0.7	25.2
13.0	28.8	14.0	41.4	0.7	24.9
13.7	28.5	14.3	42.3	0.7	24.4
14.1	28.0	14.8	42.8	0.8	24.1
14.5	27.3	15.5	40.6	0.8	23.8
14.9	27	15.8	40.7	0.9	23.5
15.3	26.8	16.0	41.4	0.9	23.3
15.6	26.5	16.3	41.5	0.9	23.1
16.4	26.2	16.6	41.4	0.9	22.6
17.2	25.7	17.1	42.5	1.0	22.1
17.6	25.5	17.3	42.9	1.0	21.9
17.9	25.2	17.6	43.0	1.0	21.8
18.3	25	17.8	42.5	1.0	21.6
18.7	24.7	18.1	42.5	1.1	21.4
19.1	24.5	18.3	42.7	1.1	21.2
19.5	24.2	18.6	42.4	1.1	21.0
20.2	24	18.8	42.6	1.2	20.7
20.6	23.4	19.4	40.8	1.2	20.5
21.4	23.2	19.6	41.1	1.2	20.2
21.7	22.9	19.9	41.3	1.3	20.1
22.1	22.7	20.1	41.5	1.3	19.9
22.5	22.4	20.4	41.4	1.4	19.8
23.3	22.2	20.6	40.8	1.4	19.5
24	21.7	21.1	41.3	1.5	19.3
24.4	21.4	21.4	41.4	1.5	19.1
24.8	21.2	21.6	41.4	1.5	19.0
25.9	20.6	22.2	41.6	1.6	18.7
26.7	20.4	22.4	41.2	1.7	18.5
27.1	20.1	22.7	41.3	1.7	18.4
28.2	19.9	22.9	41.2	1.8	18.1
29.8	19.6	23.2	40.6	1.9	17.8
30.5	19.4	23.4	41.9	1.9	17.6
30.9	19.1	23.7	41.2	2.0	17.6
31.7	18.6	24.2	40.7	2.1	17.4
32	18.1	24.7	40.5	2.3	17.4
32.4	17.6	25.2	40.7	2.5	17.3
35.9	17.3	25.5	40.9	2.6	16.8
36.6	17.1	25.7	41	2.7	16.7
44.2	16.8	26.0	41.8	2.9	16.1
45.8	16.1	26.7	41.5	3.5	16.0
46.2	15.8	27.0	41.4	4.0	16.0
47.3	15.6	27.2	41.2	4.5	15.9
56.1	15.3	27.5	41.9		15.6

P148563.PDF [Page 81 of 96]

EXHIBIT 32

ASC H2O DESORPTIION FROM 92 TO 64 %RH 2/29/86

b=0.107
R^2=0.8697

TIME	LOAD	LOSS	RH	BETA	PRELOAD
0.0	37.9	0.0	92.8	0.0	37.9
0.4	36.9	1.0	77.3	0.2	37.7
0.9	36	1.9	75.1	0.5	37.5
1.3	35.2	2.7	73.6	0.9	37.3
1.8	35	2.9	69.1	1.0	37.1
2.2	34.8	3.1	69.0	1.1	36.9
8.8	34.6	3.3	68.5	1.2	35.0
11.9	34.4	3.5	62.4	1.4	34.5
13.2	34.2	3.7	65.1	1.5	34.3
14.6	34	3.9	64.4	1.8	34.2
17.2	33.8	4.1	63.2	2.1	33.9
18.5	33.6	4.3	63.3	2.5	33.8
20.3	33.4	4.5	63.4	3.2	33.7
23.8	33.2	4.7	63.5		33.6

ASC DESORPTION FROM 65 TO 41 %RH 3/22/86

TIME	LOAD	LOSS	RH	BETA	PRELOAD
0.0	33.2	0.0	63.7	0.0	33.2
0.4	32.3	0.9	50.6	0.0	32.3
0.9	31.7	1.5	49.5	0.1	31.1
1.3	31.1	2.1	48.9	0.1	30.3
1.8	30.7	2.5	48.6	0.1	29.3
2.2	30.1	3.1	47.7	0.2	28.6
2.6	29.5	3.7	47.5	0.2	27.8
3.1	29.3	3.9	47.2	0.2	27.0
3.5	28.9	4.3	47.0	0.3	26.4
4.0	28.5	4.7	46.9	0.3	25.6
4.4	28.0	5.2	45.8	0.3	25.1
4.8	27.8	5.4	45.8	0.3	24.5
5.7	27.0	6.2	45.0	0.4	23.4
6.2	26.4	6.8	44.8	0.4	22.8
6.6	26.0	7.2	44.7	0.5	22.4
7.0	25.6	7.6	44.7	0.5	22.0
7.5	25.0	8.2	44.4	0.6	21.5
7.9	24.8	8.4	44.1	0.6	21.1
8.4	24.3	8.9	44.0	0.6	20.7
8.8	23.9	9.3	43.9	0.7	20.4
9.3	23.3	9.9	43.7	0.7	20.0
9.7	23.1	10.1	43.8	0.8	19.7
10.1	22.7	10.5	43.6	0.8	19.4
10.6	22.3	10.9	43.5	0.8	19.1
11.0	22.1	11.1	43.3	0.9	18.9
11.5	21.7	11.5	43.1	0.9	18.6
11.9	21.3	11.9	42.8	1.0	18.3
12.3	21.1	12.1	42.6	1.0	18.1
12.8	20.7	12.5	42.4	1.1	17.9
13.2	20.6	12.6	42.2	1.1	17.7
13.7	20	13.2	42.0	1.2	17.5
14.1	19.8	13.4	41.7	1.2	17.3
14.6	19.4	13.8	41.8	1.3	17.1
15	19.2	14.0	41.6	1.3	17.0
15.4	18.8	14.4	41.5	1.4	16.8
15.9	18.6	14.6	41.4	1.4	16.7
16.3	18.4	14.8	41.3	1.5	16.5
16.8	18.2	15.0	41.2	1.5	16.4
17.2	18	15.2	41.1	1.6	16.3
17.6	17.8	15.4	40.8	1.6	16.2
18.5	17.6	15.6	40.4	1.7	15.9
19.0	17.4	15.8	40.3	1.8	15.8
19.4	17	16.2	40.2	1.9	15.7
19.9	16.6	16.6	40.1	2.0	15.6
20.3	16.5	16.7	40.0	2.1	15.6
20.7	16.3	16.9	39.9	2.2	15.5
21.6	16.1	17.1	39.7	2.3	15.3
22.5	15.9	17.3	39.6	2.4	15.2
23.4	15.5	17.7	39.4	2.6	15.1
23.8	15.3	17.9	39.4	2.8	15.0
24.3	15.1	18.1	39.3	2.9	15.0
24.7	14.9	18.3	39.3	3.2	14.9
26	14.7	18.5	39.3	3.5	14.8
28.2	14.5	18.7	40	3.9	14.6
31.3	14.3	18.9	40.7	4.6	14.5
31.8	14.1	19.1	40.8		14.4

b=0.1264
R^2=0.9374

EXHIBIT 34

ASC WATER DESORPTION FROM 41 %RH 3/22/86

TIME	LOAD	LOSS	RH	BETA	PRELOAD
0.0	14.3	0.0	40.9	0	14.3
0.5	13.3	1.0	2.8	0.1	12.0
0.9	11.2	3.1	0.0	0.3	10.5
1.3	9.4	4.9	1.0	0.6	9.3
1.8	7.9	6.4	1.3	0.9	8.1
2.2	6.9	7.4	0.0	1.2	7.3
2.7	5.9	8.4	1.2	1.5	6.5
3.1	5.5	8.8	0.6	1.7	6.0
3.5	5.3	9.0	0.0	1.8	5.6
4	4.9	9.4	0.1	2.1	5.2
4.4	4.6	9.7	0.7	2.4	4.9
5.3	4.4	9.9	0.0	2.6	4.4
5.8	4.2	10.1	0.0	2.9	4.3
7.1	4	10.3	0.0	3.3	3.9
8.4	3.8	10.5	0.3	4.0	3.8
11	3.6	10.7	1.2		3.7
17.7	3.4		1.3		

b=0.4823
R^2=0.9873

APPENDIX B

EQUIPMENT

1. Data Gathering Equipment

   a. IBM-PC

      i. Two disk drives
      ii. AST SixPack card with 384K memory
      iii. Preciew monochrome graphics card
      iv. Princeton amber monitor (Max12)
      v. Epson RX-80 Printer
      vi. Serial communications card

   b. Elexor Associates PL-1000

      i. Pl-1000 contains the following
         a. 16 digital outputs
         b. 16 digital inputs
         c. two, 12 bits, analog outputs
         d. 16, 12 bits plus sign, analog inputs
         e. Real time clock with calendar
         f. 9 timers
         g. computer with RS-232 communications, BASIC interpreter in ROM, and 6K RAM
      ii. One ST-1 screw termination board

   c. Scientec 3300 balance

      i. Dual range 0-30.000/0-300.00g
      ii. RS-232 interface
      iii. Below balance weighing

   d. Omega Model 115 digital thermometer

      i. 1/16 inch Copper-Constantan thermocouple

e. General Eastern RH & temperature meter

i. Sulfonated Polystyrene detector
ii. ± 3% RH in the range of 15-99%

2. Data Manipulating Equipment

a. IBM & PL-1000 (see above)

i. Software written in BASIC
ii. Lotus 1-2-3 spreadsheet software
iii. Xstat data analysis software

3. Control Equipment

a. Omega Model FMA-115 0-500 SCCM mass flow controller
b. Needle Valve
   i. To regulate dry air blend for required RH
c. Cole-Palmer immersion circulator & water bath
d. Gas Scrubbers
   i. Consist of a 250 ml side-arm flask having
      a. A rubber stopper and a glass tube with a 4-8u glass fritted disk to disperse the air in the water.
   ii. An empty 125 ml erlenmeyer flask is in line to collect any carried-over water spray
e. Custom-made water jacketed test cell

4. Miscellaneous Equipment

a. Tubing of stainless steel, C-flex and Teflon

VENDORS

1. IBM-PC Equipment and Supplies:

IBM-PC
Two disk drives
Princeton Amber Monitor Max12
AST Research Inc.'s
SixPakPlus multifunction expansion board and
Preview monochrome graphics card
Epson RX-80 printer
printer cable
Asynch adapter and M/F RS-232 cable
IBM BASIC and DOS

Purchased from:

Frederick Computer Products, Inc.
DDI Plaza
1225 Washington Pike
Bridgeville, PA 15017
(412) 221-7510

EDDC null modem 24AWG cable (15 ft) M/F

Purchased from:

Black Box Catalog
P. O. Box 12800
Pittsburgh, PA 15241
(412) 746-5530

2. Elexor PL-1000 was purchased directly from:

Elexor Associates
P. O. Box 246
Morris Plains, NJ 07950
(201) 199-1615

3. Scientech 3300-01 dual range balance with RS-232 option was purchased directly from:

   Scientech, Inc.
   5649 Arapahoe Avenue
   Boulder, CO 80303-1399
   (800) 525-0522

4. The Omega Model 115 digital thermometer
   1/16 inch Copper-Constantan thermocouple
   Part #TJ36-CPSS-116U-12
   Omega Model EMA-DPV single channel indicator for mass flowmeter controller
   Omega Model FMA-115 0-500 SCCM mass flow controller
   Purchased directly from:
   Omega Engineering, Inc.
   One Omega Drive
   Box 4047
   Stamford, CT 06907
   (203) 359-1660

5. General Eastern Model 400C/D % Humidity/Temperature meter
   Sulfonated Polystyrene humidity detector
   Purchased from:
   W.K.M. Associates, Inc.
   90 Clairton Boulevard
   Pittsburgh, PA 15236
   (412) 892-2953

6. Cole-Parmer immersion circulator Model 1252-00
   Cooling Coil accessory R-1253-50
   Thermometer R-1252-05
   Stainless steel water bath
   C-flex and teflon tubing
   Purchased directly from:
   Cole-Parmer Instrument Co.
   7425 North Oak Park Avenue
   Chicago, IL 60648
   (800) 323-4340

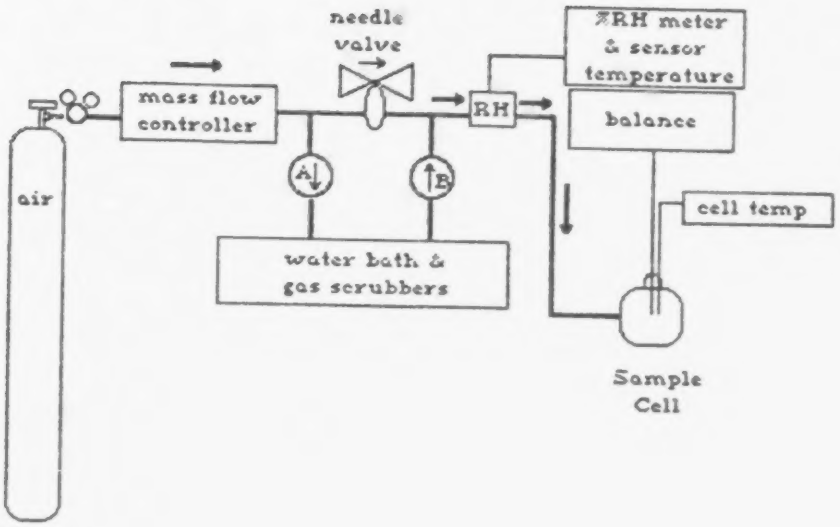
7. Design and fabrication of water-jacketed test cell
   Purchased directly from:
   Mr. Francis Roth
   1441 Arnold
   Pittsburgh, PA
   (412) 921-757

8. Lotus 123 Spreadsheet
   Purchased from:
   Lotus Corporation
   Cambridge, MA

9. XSTAT Data Analysis Software
   Purchased from:
   John Wiley & Sons
   New York, NY

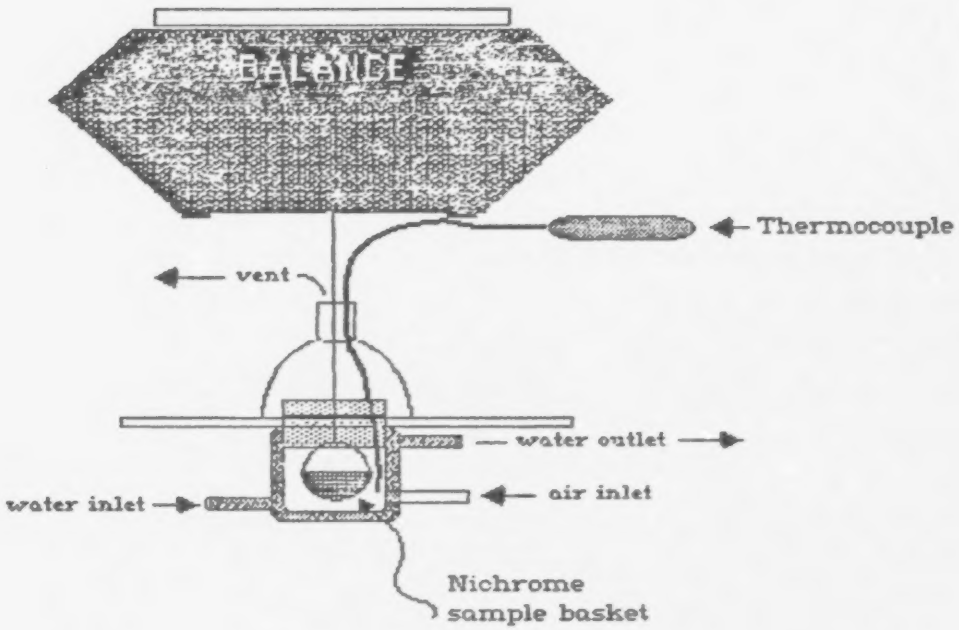
Drawing 1

FLOW DIAGRAM



Drawing 2

BALANCE & SAMPLE CELL



APPENDIX C

```
10      REM                 STARTER APRIL 3
20      DIM W(60)
30      DIM C$(1)
40 DIM D$(1,3)
50 COMMON F$,W$(0),B$
60 INPUT"IN LESS THAN 8 CHARACTERS - WHAT IS DATA FILE NAME";N$
70 F$="B:"+N$+".PRN"
73 INPUT "Is this an  1) ADSORPTION  or  2) DESORPTION  run";SORP
75 IF SORP<>2 THEN GOTO 80
77 INPUT"Enter the ORIGINAL clean sample weight";AT
80 INPUT"CARBON TYPE";CT$
90 INPUT"A.D";AD$
100 NI$="B:"+N$+".DAT"
110 A=0
115 IF SORP=2 THEN GOTO 140
120 FOR A=1 TO 12
130 CLOSE #3
140 OPEN NI$ FOR OUTPUT AS #3
150 PRINT #3, N$
160 PRINT #3, F$
170 PRINT #3, CT$
180 PRINT #3, AD$
185 IF SORP=2 THEN GOTO 300
190 OPEN "COM2:300,N,7,2,CS,DS,CD" AS #2:REM    300BAUD,NO PARITY,7DATA,2STOP,
                                                   DISABLES CLEAR-TO-SEND;
                                                   DATA-SET-READY:CARRIER-DETECT

200 INPUT #2,C,W(A)                            :REM   GETS WEIGHT FROM BALANCE
210 CLOSE #2                                   :REM   DROPS VOLTAGE TO BALANCE WHICH
                                                      ALLOWS BALANCE TO GET READY
                                                      TO SEND DATA

220 FOR D=1 TO 700:NEXT D
230 PRINT W(A),
240 IF W(A)<=0 THEN 190
250 CT=CT+W(A)
260 PRINT CT
270 NEXT A
280 AT=CT/12                                   :REM    C$(0)=AVE. STARTING WEIGHT
290 PRINT W$(0)
300 W$(0)=STR$(AT)
305 PRINT #3, "STARTING WT=";W$(0)
310 B$=TIME$                                   :REM   READS HARDWARE CLOCK
320 PRINT B$,W$(0),                            :REM   PRINTS TIME & WEIGHT TO SCREEN
330 PRINT "PL-1000 ";D$(J,JJ)
340 CLOSE #1
350 OPEN "COM1:300,O,7,1" AS #1                :REM    OPENS COMUNICATIONS TO PL-1000.
                                                       300 BAUD,ODD PARITY, 7 DATA
                                                       BITS, 1 STOP BIT.

360 FOR JJ= 0 TO 2
370 PRINT #1,"PRINT AINP(";JJ;");"             :REM    REQUEST DATA FROM DESIGNATED A/D
                                                       PORT
380 SOUND 16199,60:SOUND 37, 3                 :REM    HIGH PITCHED SOUND DRIVES OUT
                                                       ANY BUGS IN PROGRAM (ALSO
                                                       HIGHEST PITCH DAE CAN HEAR)

390 IF EOF(1) THEN 510                         :REM    CHECKS EOF TO SEE IF ANY
                                                       TRANSMISSION CAME BACK
400 INPUT#1,C$                                 :REM    GARBAGE COLLECTOR
410 INPUT#1,D$(J,JJ)                           :REM    ** THIS IS THE DATA **
420 IF EOF(1) THEN 440                         :REM    IF BUFFER IS EMPTY NO FURTHER
                                                       GARBAGE COLLECTION TAKES
                                                       PLACE
430 D$=INPUT$(LOC(1),#1)                       :REM    GARBAGE COLLECTOR #2
440 IF ASC(D$(J,JJ))>31 AND ASC(D$(J,JJ))<58 THEN 450 ELSE 330
450 IF JJ=0 THEN S$="THE DEW POINT VALUE IS "
460 IF JJ=1 THEN S$="THE FLOW VALUE IS "
470 IF JJ=2 THEN S$="THE TEMPERATURE VALUE IS "
480     PRINT S$;D$(J,JJ)
490     PRINT #3,D$(J,JJ)
500 NEXT JJ                                    :REM    RETURNS TO BEGINING OF PL-1000
                                                       DATA COLLECTION TO READ
                                                       REMAINING PORTS
510 CLOSE #1                                   :REM    CLOSES THE COMMUNICATION PORT TO
                                                       PL-1000

520 CHAIN "DATACO",200
```

```
 QD=1200                                                    :REM SECONDS BETWEEN POI
;
      DIM ETIME(100)
      DIM PERLOD(100)
      DIM D(100,4)
      DIM WT(100)
      DIM TIMECHANGE(100)
DIM X(100)     :     DIM Y(100)     :     DIM A(10,20)     :     DIM B(100)     :
 Z(100)
       DEF FNRH(X)= 4.804962396145#*X^0+.3460057239368#*X^1+.0093565315997582#
2+1.6085014958233D-04*X^3+3.5970773313736D-06*X^4-1.3161323553209D-08*X^5-8.6
3178095D-10*X^6+2.8153038550992D-11*X^7-2.905947519D-13*X^8+1.040113519329 8D-
*X^9
      INPUT"WHAT IS DATA FILE NAME";F$
     GOTO 300
     REM                        START OF CHAINED PROGRAM
 QD=1200                                                    :REM SECONDS BETWEEN POI
;
     DIM ETIME(100)
     DIM PERLOD(100)
     DIM D(100,4)
     DIM WT(100),W(1)
    DIM TIMECHANGE(100)
  DIM X(100)     :     DIM Y(100)     :     DIM A(10,20)     :     DIM B(100)     :
IM Z(100)
      DEF FNRH(X)= 4.804962396145#*X^0+.3460057239368#*X^1+.0093565315997582#*
+1.6085014958233D-04*X^3+3.5970773313736D-06*X^4-1.3161323553209D-08*X^5-8.69
3178095D-10*X^6+2.8153038550992D-11*X^7-2.905947519D-13*X^8+1.040113519329 8D-1
^9
 CLOSE
 REM
 REM         THE FOLLOWING COMMUNICATES WITH THE SCIENTECH 3300 BALANCE OVER T
2ND RS-232 LINE.  THE LINES FROM THE IBM TO THE SCIENTECH ARE AS FOLLOWS: PIN
TO PIN#1;PIN#2 TO NOTHING;PIN#3 TO PIN#2;
 WTO=VAL(LEFT$(W$(0),9))      :REM    CONVERTS STARTING WEIGHT TO A NUMERIC VE
BLE
  XX=TIMER
 CLOSE
 I=0 : N=1 : WT=0
 J=J+1
 PRINT"J =";J
 OPEN F$ FOR APPEND AS #3
 OPEN "COM2:300,N,7,2,CS,DS,CD" AS #2:REM    300BAUD,NO PARITY,7DATA,2STOP, D
BLES CLEAR-TO-SEND; DATA-SET-READY; CARRIER-DETECT
 A$=DATE$                                  :REM   READS HARDWARE CALENDER
 T$=TIME$                                     :REM   READS HARDWARE CLOCK
 INPUT #2,CC$                                  :REM   GETS WEIGHT FROM BALANCE
 WTS=VAL(MID$(CC$,2))                 :REM    CONVERTS WEIGHT TO A NUMERIC VERIABLE
 CLOSE #2                                     :REM   DROPS VOLTAGE TO BALANCE WHICH AL
S BALANCE TO GET READY TO SEND DATA
 WT=WT+WTS
 I=I+1
 FOR Z=1 TO 4000 : NEXT Z : Z=0
 IF I<10 THEN GOTO 330
 PRINT"?????????";I
 WT=WT/I
 WT(J)=WT       :REM    CONVERTS WEIGHT TO A NUMERIC VERIABLE
 OPEN "COM1:300,O,7,1" AS #1          :REM    OPENS COMUNICATIONS TO PL-1000.
 BAUD,ODD PARITY, 7 DATA  BITS, 1 STOP BIT.
 FOR JJ= 0 TO 3
 PRINT #1,"PRINT AINP(";JJ;");"       :REM    REQUEST DATA FROM DESIGNATED A/D
RT
 SOUND 16199,60:SOUND 37, 3           :REM    HIGH PITCHED SOUND DRIVES OUT AN
UGS IN PROGRAM (ALSO HIGHEST PITCH DAE CAN HEAR)
```

```
IF EOF(1) THEN CLOSE #1:GOTO 410          :REM    CHECKS EOF TO SEE IF ANY TRANSM
ION CAME BACK
 INPUT#1,G$                               :REM    GARBAGE COLLECTOR
 INPUT#1,D(J,JJ)                          :REM    ** THIS IS THE DATA **
 IF EOF(1) THEN 510                       :REM    IF BUFFER IS EMPTY NO FURTHER GA
GE COLLECTION TAKES PLACE
 G$=INPUT$(LOC(1),#1)                     :REM    GARBAGE COLLECTOR #2
 NEXT JJ                                  :REM    RETURNS TO BEGINING OF PL-1000 D
 COLLECTION TO READ REMAINING PORTS
 CLOSE #1                                 :REM    CLOSES THE COMMUNICATION PORT TO
-1000
 J1=J1+1
 PRINT:PRINT"                          ";J1;"SETS OF DATA POINTS"
 LPRINT:LPRINT:LPRINT"                          ";J1;"SETS OF DATA POINTS"
 PRINT A$,T$,WT(J)                        :REM   PRINTS DATE, TIME & WEIGHT TO SCR

 LPRINT A$,T$,WT(J),                      :REM   PRINTS DATE, TIME & WEIGHT TO PR
ER
 MID$(A$,3)="/"                           :REM    REPLACES DASH IN DATE WITH SLASH
 MID$(A$,6)="/"                           :REM    REPLACES DASH IN DATE WITH SLASH
 PRINT #3,A$,                             :REM    SAVES DATE TO DISK
 STARTIME=VAL(LEFT$(B$,2))*60+VAL(MID$(B$,4,2))
 PRINT #3,T$,                             :REM    SAVES TIME TO DISK
 ETIME(J)=VAL(LEFT$(T$,2))*60+VAL(MID$(T$,4,2))-STARTIME
 IF J<>1 THEN IF ETIME(J)<ETIME(J-1) THEN STARTIME=STARTIME-1440 : GOTO 630
 PRINT #3,ETIME(J),                       :REM    SAVES ELAPSED TIME TO DISK
 PRINT "ELAPSED TIME =";ETIME(J);" MIN."
 LPRINT "ELAPSED TIME =";ETIME(J);" MIN."
 PERLOD(J)=((WT(J)-WTO)/WTO)*100          :REM    PERCENT WEIGHT LOADING
 PRINT #3,PERLOD(J),                      :REM    SAVES WEIGHT LOADING DISK
 PRINT"PERCENT WEIGHT LOADING =";PERLOD(J);"%"
 LPRINT"PERCENT WEIGHT LOADING =";PERLOD(J);"%"
 FOR JJ= 0 TO 3
 IF JJ=0 THEN S$="THE % RELATIVE HUMIDITY VALUE IS ":CONSTANT=40:PRINT"**RH V
AGE= ";D(J,JJ);"  **"
 IF JJ=1 THEN S$=" THE %RH TEMP IS ":CONSTANT=50
 IF JJ=2 THEN S$="THE FLOW VALUE IS ":CONSTANT=50
 IF JJ=3 THEN S$=" THE CELL TEMP IS ":CONSTANT=1
     PRINT S$;D(J,JJ)/CONSTANT
    LPRINT S$;D(J,JJ)/CONSTANT,           :REM    PRINTS PL-1000 DATA TO PRINTER
    REM PRINT #3,D(J,JJ)/CONSTANT,
 NEXT JJ                                  :REM    RETURNS TO BEGINING OF PL-1000
                                                  DATA COLLECTION TO READ
                                                  REMAINING PORTS
 REM    CALCULATION OF DEW POINT FROM %RH & RH TEMP
 REM     DEWPT=%RH/100*G*M3(RH TEMP)
 X=(((D(J,1)/50)-32)*5)/9     :     RH=D(J,0)/40     :     CELLTEMP=D(J,3)
 DEWPTGM3= (RH/100)*FNRH(X)
 CELLRH=(DEWPTGM3/FNRH(CELLTEMP))*100
     PRINT "CALCULATED % RELATIVE HUMIDITY ";CELLRH
    LPRINT "CALCULATED % RELATIVE HUMIDITY ";CELLRH       :REM   PRINTS CALCU
ED % RELATIVE HUMIDITY TO PRINTER
     PRINT #3,CELLRH
 IF XX>=86400!-QD THEN XX=XX-86400!                  :REM CORRECT FOR MIDNIGHT
 IF TIMER>=XX+QD THEN GOTO 300 ELSE 860
```

P148563.PDF [Page: 96 of 96]

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CORPORATE AUTHOR: Defence Research Establishment Ottawa, Ottawa ONT (CAN);Calgon Carbon Corp, Pittsburgh PA (US)

ABSTRACT: (U) The rate of water uptake on ASC and ASC base carbon has been measured at different relative humidities. Equations have benn proposed to define the water uptake on the carbons and the constants in these equations determined.

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